TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XII, No. 6 JUNE, 1935. PRICE 6d.

CONTENTS.

	PAGE.
The West Indian Fruit and Vegetable Council	137
Effects of drought on yield of Coconuts	138
An Entomological Investigation in St. Vincent	139
Miscellaneous Notes	144
Citrus Fruit-Rots in Trinidad	145
Rubber Strips	152
Agricultural Labour in Trinidad	153
West Indian Entomological Notes	158
Crop Products Manufacture	161
Use of Fuller's Earth gel on Molasses Fermentation Liquors	162
Reviews :—	
The Diseases and Curing of Cacao	163
Diseases of the Banana and of the Manila Hemp Plant	163
The Genetics of Garden Plants	165
The College Sugar Factory	165
Chemical Notes	166
Sugar Notes	167
Trend of the Markets	168

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE WEST INDIAN FRUIT AND VEGETABLE COUNCIL.

Eastern Group.

It will be recalled that the establishment of some means for co-ordinating the production and marketing of fruit and vegetables in the West Indies, in order to avoid the adverse effects of competitive selling upon market prices, was recognised at the Jamaica Fruit and Vegetable Conference in 1933. It was felt, in this connection, that central representative bodies would prove of material assistance in advancing the co-operative movement. Recommendations followed for establishing two West Indian Fruit and Vegetable Councils, one of which was to serve the Eastern Group, comprising British Guiana, Trinidad, the Windward and Leeward Islands, Barbados and Bermuda with headquarters in Trinidad, and the other, the Western group, consisting of Jamaica, British Honduras and the Bahamas, with headquarters in Jamaica. The Councils' main functions were to include the collection and publication of information relating to production, markets and marketing; the encouragement of co-operative efforts in the individual colonies and amongst colonies, the direction of the Marketing Intelligence Service recommended by the Conference and the administration of funds raised for advertising. Each Council was to meet annually and the two Councils together every three years. Quite recently the first meeting of the Council for the Eastern Group was held in St. Lucia. It was opened by His Honour, the Acting Administrator, and attended by both official and unofficial representatives from Trinidad, Grenada, St. Lucia, Dominica and St. Vincent. The Commissioner of Agriculture who was elected President of the Council, represented the Imperial College of Tropical Agriculture and St. Vincent. Many items of interest concerning the fruit and vegetable industries of the Eastern Group were discussed and it is proposed here to summarise briefly the results of the meeting.

The first item on the Council's agenda was to ascertain how far the findings of the St. Lucia and Jamaica Conferences had been carried out and to consider in what respect amendments to those recommendations were necessary or desirable in the light of experience gained to date. It was found that no steps had been taken to appoint a Marketing Intelligence Officer in Canada, although such an appointment would have been of particular assistance to the vegetable and fruit

industries of Bermuda. It was generally felt that the extent of the trade in fruit and vegetables with Canada of the Colonies represented would not at present justify the expenses of such an officer, but suggested instead that the office of the Canadian Trade Commissioner might be in a position to carry out part of the duties of a Marketing Intelligence Officer. Special arrangements were accordingly made to interview the Canadian Trade Commissioner on this matter during his forthcoming visit to the West Indies. Attention was next drawn to the situation resulting from the termination of the appointment of the local Marketing Officer and to the need for maintaining the usefulness and efficiency of the work which was organised and supervised by that officer. The President reported that in future this work would as far as possible be undertaken by the staff of the Agricultural Advisory Department of the Imperial College of Tropical Agriculture. It was recommended, moreover, that in order to aid this work the Co-operative Citrus Growers' Association of Trinidad and Tobago be approached in regard to the loan, on occasions of emergency, of the services of their packing house expert for visits to the Colonies in so far as the execution of that officer's primary duties would permit. The Council also examined the subjects of export duties on fruit and vegetables and of the import duties imposed on packages and packing materials. It was recommended in this connection that where duties existed, there should be uniformity in the rates of export duties on fresh fruits and vegetables, and that import duties on packages and packing materials for re-export were undesirable and not in the best interests of the fruit and vegetable industry. Stress was laid on the need for participating in exhibitions and it was recommended that the colonies represented in the Eastern Group should, from time to time, participate collectively in such exhibitions and that a person or persons suitably qualified should be in attendance.

Considerable attention was paid to various aspects of the lime industry. The Council agreed that there was pressing need for co-operation in the marketing of lime oils and at its suggestion a meeting was arranged between the Dominica and St. Lucia members and the St. Lucia lime oil producers to discuss the advantages and possible methods of co-operation. Arrangements were also made for representatives from Dominica and St. Lucia to visit Trinidad at an early date in order to discuss the subject with representatives of the lime oil producers in Trinidad. The shipping of green limes on consignment was discussed at some length. It was generally agreed that this practice was a contributing factor in depressing the market and that it would be in the interests of the growers to discontinue it. The suggestion was put forward that the various interests should endeavour to maintain a minimum F.O.B. selling price for green limes by co-operative agreement. The Council also recommended that all limes prepared for shipment to the United States should be liable to inspection by authorised inspectors, and that all limes intended for shipment to the United Kingdom or Canada should be packed in packing houses approved by Government and inspected by Government inspectors.

The position of the grapefruit industry was carefully examined. Detailed statements regarding shipments, costs of production and world statistics of the crop were submitted which revealed that the British West Indies were on the whole favourably placed in comparison with other producing countries. The development of the industry, however, is being somewhat hampered in certain of the colonies, by inadequate shipping facilities and high freight rates and possible measures for overcoming these difficulties were advocated. Attention was also drawn to the disparity of the preferences on grapefruit and grapefruit juice in the United Kingdom and efforts will be made to readjust the existing tariff rates.

Matters relating to the banana and mango industries were discussed. It was noted that striking progress had been made in the development of the former industry while in regard to the latter it was recommended that further research should be conducted into the conditions affecting the satisfactory transport of the Julie, Bombay and Ceylon No. 1 varieties of mangoes.

The investigations into storage requirements of various fruits and vegetables undertaken by the Low Temperature Research Station of the College since the Jamaica Conference, were considered. The Council recorded its appreciation of the work accomplished by this Station and expressed the hope that arrangements would be made for the continuance of this research work which it considered of great importance to the fruit and vegetable industries of the British West Indies.

EFFECTS OF DROUGHT ON YIELD OF COCONUTS.

In the *Tropical Agriculturist*, Vol. LXXXIII, pp. 141-50, M. Park from the examination of yield records from a group of coconut estates in the Puttalam district, Ceylon, shows that a severe drought in 1931 affected the yield of nuts for a period of two years with a maximum effect about 13 months, after the conclusion of the drought, at which time the yield had sunk to about 30 per cent. of the average for seven years. A sharp rise in yield during the drought is thought to be partly due to the physiological shedding of nuts approaching maturity. The size of nut as indicated by the amount of copra per nut was decreased for one year only with a maximum effect about six months after the end of the drought.

FOR SALE.

"NATURE TEACHING" by Sir Francis Watts. 6th Edition 1934, price 3s. 6*d*. Obtainable from: The Secretary, West India Committee, 14, Trinity Square, London E.C.3., England.

AN ENTOMOLOGICAL INVESTIGATION IN ST. VINCENT.*

By J. G. Myers, SCD., F.R.E.S., F.Z.S.,
Biological Control Research Officer, Imperial Institute of Entomology and Imperial College of Tropical Agriculture.

I. Introduction and Acknowledgments.

The brief visit here reported on arose out of the need for more definite information about cane pests in St. Vincent with a view to their control and for comparison with their status in the other islands. I was instructed to study the moth-borer position and also advise on arrowroot and cotton pests. Incidental observations were made on other insects during rather less than a week's stay. Owing to the courtesy of His Honour the Administrator, Mr. A. Grimble, C.M.G., and the energy and enthusiasm of the Agricultural Superintendent, Mr. A. K. Briant, I was enabled to see a very considerable part of the island. Mr. Briant and (or) the Agricultural Assistant, Mr. C. K. Robinson, the Arrowroot-Research Officer, accompanied me on every field excursion, and I am greatly indebted to them both for their very keen interest and assistance. Mr. S. H. Evelyn, the Cotton Research Officer, was also most helpful. I owe very much finally, to the hospitality of planters throughout the island.

II. General Ecological Considerations.

Much important ecological information is contained in the recent soil report of Professor Hardy and his collaborators (1934). There are further data in Myers (1931), but so far as I am aware there has been no general study of the plant ecology. The island, about 130 miles in area, is highly mountainous (rising to 4,000 feet), well-watered and with a generally high rainfall, the effects of which are considerably offset by uniformly light soils, derived largely from recent volcanic ejectamenta, and very little retentive of water. As a result of the latter and of good natural drainage the relative atmospheric humidity is comparatively low, and the island is ecologically to be counted among the drier of the Lesser Antilles. This is reflected in heavy incidence of scale-insects and of the accompanying unsightly "black blight" fungus on a variety of plants.

The original vegetation has been profoundly modified below 2,000 feet by settlement even where not by actual cultivation. Three zones can, however, be distinguished, and characterised briefly: (1) a lower zone, below about 1,500 feet, corresponding with the "middle belt" of Grenada but extending everywhere to the coast, since there is no dry deciduous scrub belt as in Grenada. The chief woody plants are *Tecoma leucoxylon*, *T. stans*, *Andira inermis*, *Hymenaea Courbaril*, *Psidium guayava*, *Croton* spp., *Leucaena glauca*, *Gliricidia maculata*, *Cassia bacillaris*, *Lantana* spp., *Bursera simaruba*, some logwood, and of course, numerous mango, breadfruit and tamarind trees. The chief conspicuous grasses are *Valota insularis*, *Pennisetum setosum*, *Paspalum fimbriatum*, Guinea grass (*Panicum maximum*), *Axonopus compressus*, *Sporobolus indicus*, *Vetiveria zizanioides*, Johnson grass (*Sorghum halepense*). The original vegetation of this belt, judging by remnants on the steeper slopes of the deeper leeward valleys, was dominated at least in certain areas, by *Acrocomia* palms and consisted of tropical rain-forest of a somewhat drier type than in the next zone. (2) a moist rain-forest belt above about 1,500 feet, corresponding with the "mountain belt" in Grenada. Of this I saw only the Soufrière type, which is obviously still "second-growth" consequent on the famous 1902 eruption, and dominated by *Inga*, *Cecropia*, *Heliconia Bihai*. Plant elements of wet rain forest, *e.g.* *Xanthosoma*, *Heliconia Bihai*, *Inga*, *Hedychium*, *Piper*, follow the water-courses down the deep leeward valleys to about 400 feet. (3) Beginning at about 2,000 feet on the Soufrière, is a belt of scrub passing soon into an alpine fell-field zone of sparse herbs and other low plants, which in comparison for instance with Mt. Misery in St. Kitts, has probably been extended downward by the effects of the eruption.

Agriculture is largely confined to the lower zone and about 60 per cent. of the whole island area is said to be under cultivation—thus a greater proportion than in Grenada. There is considerable peasant cultivation, and the high relief, and absence of any very considerable flats —all these tend to comparative restriction and isolation of areas under any one crop, though the large coconut estate of Orange Hill is one exception. Insectivorous small birds are generally much more abundant than in Grenada. So also is the mongoose, perhaps partly owing to the more favourable climate and partly to the fact that dogs are restricted by a licence (though only half the amount) in the country as well as in the town. As a result the useful ground-lizard (*Ameiva aquilina*) is so rare that it was reported extinct (Barbour, 1930); but I was able to find a few at one point on the windward coast. Leaf-lizards (*Anolis vincentii*) are exceedingly abundant up to at least 1,200 feet. The giant toad (*Bufo marinus*) which has been introduced and established in so many of the islands from Grenada to Porto Rico and Jamaica, and was recently imported into Hawaii against insect pests, is not present in St. Vincent. The introduction of vertebrates is usually attended with more risks and uncertainties than that of specifically parasitic insects, and the best opinion is generally opposed to it; but in view of the clean record of this toad, and of the careful study made of it in Porto Rico, I recommend that it be imported into St. Vincent.

* Extracted from a Report submitted by Dr. Myers.

III. Sugar-cane Moth-borers (*Diatraea* spp.).

The remarks made in my recent Grenada report anent the fact that moth-borers (*Diatraea*) are much less prevalent in peasant cultivations than under estate conditions apply also to St. Vincent; but there is a tendency in the latter island for the estate cane-areas to be larger and more continuous. As Hardy states, "the chief sugar-cane lands at the present time are situated on the broad coastal plain lying between Georgetown and Orange Hill in the north-east, and on the flat alluvial plains at the mouths of the rivers of the south-west leeward coast", and both these districts offer more extensive flats than are anywhere available in Grenada. We should therefore expect the St. Vincent infestation to be somewhat higher. Actually it is slightly lower (joint infestation eight per cent., as compared with nine per cent.), but the difference is not very significant, especially as the stalk infestation is rather higher (48 per cent., as compared with 42 per cent. in Grenada). The joint infestation, it may be mentioned, gives, of course, the truer index of damage. There are as in Grenada two species of moth-borers attacking cane in St. Vincent, namely the black-headed (*Diatraea saccharalis*) and the yellow-headed.

1. Infestation and Distribution.

As in Grenada, the infestation of representative randomised stools was examined wherever canes were found, and often plant fields were not available. The samples, totalling 445 canes (with 4,854 joints) and shoots showed 52.7 per cent. of the shoots killed by *Diatraea*, 48 per cent. of the stalks bored and 7.8 per cent. of the joints, the corresponding Grenada figures being 43.2, 42.3 and 8.9 respectively. This, if there were a simple arithmetical relation, would involve a loss in final sugar production in St. Vincent, of about seven to eight per cent., but actually the loss is probably somewhat lower. This, while very far from negligible, is unusually low for the Lesser Antilles, but may be expected to increase if and when cane cultivation is extended to larger areas, under estate conditions. It must be emphasised that these are only preliminary scouting figures.

Most of the canes examined were B.H. 10/12, which is by way of being the standard variety throughout the island estates. Next came Ba 11569 and P.O.J. 2878, while the peasant canes are largely Bourbon. Both on leeward and on windward estates I saw some magnificent canes, with, on the north-east especially, surprisingly low infestation. A sample stool of 1st ratoon P.O.J. 2878, for instance—a variety usually considered very susceptible to borer attack—yielded 21 splendid canes, not one of which was bored.

The average joint infestation on the leeward coast estates was 8.8 per cent. and on the windward 6.1. This is correlated with the lower rainfall of the windward slopes.

The high infestation of young shoots (over half of them killed) is associated with the prevalence of the yellow-headed borer (*Diatraea canella*), which strongly prefers shoots to hard canes.

2.—Wild Host-plants of Borers.

Of great importance in the borer question, especially from the point of view of biological control, are the number and distribution of wild host-plants. The following wild grasses were found infested with borer in St. Vincent.—

Valota insularis, with *Diatraea saccharalis*.
Coix lacrima-jobi, Job's Tears, or Job's seeds, with *D. saccharalis*.
Panicum barbinode, Pará grass, with *D. saccharalis*.
Cymbopogon citratus, Lemon grass, with *D. canella*.
Vetiveria zizanioides, khus-khus grass, with both species.
Eleusine indica, with both species.
Paspalum virgatum, with both species.

These are largely weed-grasses, save lemon-grass, which is a garden plant, especially beloved of peasants, and khus-khus, which is used very extensively (much more than in Grenada) for planting on road-side banks. *Valota* is a common roadside and wasteland grass, as also is *Eleusine*. Job's Tears grows in great abundance along all the lower courses of most of the streams, especially on the leeward side. *Paspalum virgatum* is widespread as a roadside grass in all the wetter and higher areas, where it takes the place of the *Valota* which prefers lower and drier sites. Both these two grasses, and khus-khus, support a large borer population often far distant from the nearest cane cultivation and with Job's Tears, are the four most important wild hosts. This list of wild grass hosts is probably very far from exhaustive. There are several other abundant grasses in St. Vincent which have been recorded elsewhere as occasional hosts of *Diatraea* spp. These include the giant reed or roseau (*Gynerium sagittatum*), *Paspalum saccharoides* (which occurs right up to the lip of the Soufrière Crater), *Setaria barbata*, *Leptochloa virgata*. Guinea grass is said to be a host but I have never found it attacked. The wild grass-hosts serve as a reservoir of borer infestation, but also as a reservoir for borer parasites, which are usually much more abundant in them than in cane.

Maize, which I did not find attacked in Grenada, is commonly very heavily infested by the cane borer (*Diatraea saccharalis*) in St. Vincent.

3.—Natural Enemies.

Both the time and material procurable were insufficient to yield adequate figures of the extent to which the borer is attacked in sugar-cane and grasses, by its various natural enemies. Parasites of Diatraea may be divided into those attacking eggs, larvae and pupae respectively. Trinidad would appear to be the northern limit of pupal parasites. What is of greater practical importance (since pupal parasites are of little value in *Diatraea* control) is the fact that the two occasionally efficient Tachinid parasites (*Paratheresia claripalpis* and *Stomatodexia diadema*) found as far north as Trinidad, do not occur in St. Vincent.

As regards egg-parasites, the larger one (*Prophanurus alecto*) is much more abundant than *Trichogramma minutum*, though the latter is not so scarce as in Grenada.

There follows a list of the parasites of *Diatraea* in St. Vincent :—

Attacking the egg :—*Trichogramma minutum.*
Prophanurus alecto.
Attacking the larva :—*Microdus stigmaterus.*

As elsewhere, the larval parasites attack much more readily and frequently the borers in wild grasses than those in cane. The combined attack of the above parasites, especially on the borer population in cane, is probably almost negligible economically, and there is a clear and promising field, as in Grenada, for the introduction of one of the three more efficient of the Tachinid parasites known (*Lixophaga*, *Paratheresia* and *Metagonistylum*), and of a specific parasite, when found for *Diatraea canella*. From ecological considerations I believe that *Lixophaga* or *Paratheresia* is indicated for introduction against *D. saccharalis*. I suggest that, as the present borer infestation is comparatively small, the decision may wait a year or two until we know the results of experiments with both these flies now under way in Antigua and Barbados. In the meantime it would be advisable to survey the infestation from time to time, and I would suggest that arrangements be made for Mr. Box, who is in charge of borer work in the Leeward Islands and in St. Lucia, to pay periodic visits. He could probably initiate mill surveys during the grinding season, which could be supervised, in his absence, by the Assistant Agricultural Superintendent.

IV. Arrowroot Pests.

Since the arrowroot crop had been the subject of special full-time research by Mr. C. K. Robinson, under the auspices of the Co-operative Arrowroot Association, while its pests had been studied by Mr. Urich on two successive visits, much more information was available than in the case of sugar-cane. I need not recapitulate Mr. Urich's excellent report (in *Tropical Agriculture*).

In addition to my own field observations I had the benefit of the fullest discussions with Mr. Robinson, whose experimental programme seemed to me very well thought out, and I had read all his reports.

The possibility of biological control for the arrowroot worm (*Calpodes ethlius*) has long been envisaged. I should therefore like to emphasize the importance of what we may call Marshall's law—namely—that the cost of a biological control project should not be greater than half the amount of the estimated annual damage. While this may not apply to continental areas where immense *potential* issues are at stake, in small Colonies with limited means it is a very useful practical guide. The necessity of estimating with some accuracy the damage caused by the arrowroot worm is the more pressing from the fact that, as I understand, there are some planters who believe that no loss whatever is inflicted on the crop. There are, however, five points under which damage may be visualised and should be investigated :—

(*a*) Direct damage in the destruction of plants.

(*b*) Depletion of rhizomes by new shooting to replace foliage destroyed.

(*c*) The new shoots, being more attractive, initiate a new cycle of attack.

(*d*) Cost of extra weeding, when the cover is opened up by defoliation, and many more weeds gain entry.

(*e*) Damage done by the weeders, especially when the crop is advanced.

Mr. Robinson has already experiments in progress to determine the loss [under (*a*)-(*c*)] by measuring exactly the effect of *complete* defoliation at different periods in the growth of the crop. We shall then have a standard by which to estimate the results of various degrees of *partial* defoliation. These experiments should be carried out both as field plot tests and as pot-experiments.

The second essential preliminary to any scheme of biological control is a thorough study of the natural enemies already present in St. Vincent and an estimate of their efficiency under various conditions. Mr. Robinson has already made considerable progress in this work, and is capable of carrying it to a useful conclusion provided he receives prompt entomological assistance from time to time, especially with regard to the identification of insects reared. This could best be accomplished by putting him in close touch with Mr. Box, or with one of the entomologists at the College.

The following parasites are now known in St. Vincent, as a result of the investigations of Harland, Urich and Robinson :—

Attacking eggs :—*Trichogramma minutum*
Undetermined parasite (Harland).
Attacking larvae and (*or*) *pupae* :—*Elachertus meridionalis*, *Eucelatoria australis*, *Phorocera floridensis* Towns., *Sarcophaga lambens* (=*Sarcodexia sternodontis*), *Sarcophaga* (*Oxysarcodexia*) sp., *Brachymeria annulata* (new record, Robinson).

In discussing the efficiency of egg-parasites, it is most important that the extent of young larval mortality should be known—*i.e.*, the proportion of young larvae which die in any event before establishing themselves in a feeding position. This is not known, and it should be ascertained by exact counts in connection with further biological studies of the pest itself.

The results of previous investigators show that the most efficient parasites now present are "Tachinids", but owing to the great difficulties of study in this group, we are almost completely in the dark as to which insects are really doing the work. *Eucelatoria australis* and *Phorocera floridensis* are true Tachinids in the strict sense and would therefore probably be the most efficient but they do not specialise on *Calpodes*,

while *Sarcophaga lambens** is a Sarcophagid, with a wide range of hosts elsewhere and no record of efficiency. The new *Sarcophaga* found by Mr. Urich is probably equally indiscriminate. Yet all the flies reared from *Calpodes* pupae and submitted to me by Mr. Robinson are Sarcophagids. Mr. Urich has also found two Tachinids attacking the larva in Trinidad, namely, *Achaetoneura nigripalpis* and *Exoristoides urichi* and, *as these are apparently not already present in St. Vincent*, they, or the more effective of the two, *should certainly be introduced into St. Vincent, as the most promising foreign parasites at present known.* There is, however, pressing need for the continued rearing, on a large scale, of all the fly parasites present in St. Vincent, and the prompt submission of specimens to a specialist in this difficult group, in order to determine which are the most efficient at present. There is already a long list of parasites known to attack the arrowroot worm in other countries. Apart from the Trinidad Tachinids above mentioned, the most noteworthy is an egg-parasite, *Xenufens rushini*, which in Cuba kills up to 100 per cent. of the eggs. But for all that is known at present, the unidentified St. Vincent egg-parasite listed above as reared by Dr. Harland may be the same species, so that here again we are handicapped by the need for further rearing and investigation in St. Vincent.

The small wasp, *Apanteles talidicida*, which attacks the larvae in Trinidad, is by no means promising, and the abortive and perhaps somewhat premature attempt which has already been made to introduce it into St. Vincent need not be repeated, more especially as Mr. Robinson had previously reared in St. Vincent a species of *Apanteles* which may well be the same. More material of this St. Vincent *Apanteles* is urgently needed for determination. This is a genus in which identification can be readily and quickly secured.

Bound up with the question of parasites is that of alternate host-plants. These include chiefly garden cannas and the wild *Canna coccinea*. The former seem to be favourite garden plants of the arrowroot planters. It is important that the extent of attack by various parasites on the *Calpodes* population of these alternate host plants should be studied. *Maranta indica*, a kind of wild arrowroot, is said to be rare, but ought to be investigated.

As regards the predatory enemies of the arrowroot worm, these are undoubtedly at present more important in St. Vincent than the parasites. The biological investigator is singularly fortunate in having, in *Calpodes*, through the sedentary habits of its intermediate stages, and the easy recognition of the bentover leaf shelters of larvae and pupae, a pest in which it is unusually easy to measure with some exactitude the incidence of predatism.

The chief predators of the larvae are wasps or Jack Spaniards (*Polistes annularis*), lizards (*Anolis vincentii*) and birds. The pupae are chiefly attacked by birds, the pupal shelters being apparently largely impregnable to lizards and wasps. Large centipedes (not yet named), which are not uncommon in arrowroot fields, also eat the pupae.

The Jack Spaniard position in St. Vincent is of extreme biological interest not only in connection with the arrowroot industry. It has attracted the attention of every previous investigator, since these wasps are far more abundant in St. Vincent than anywhere else I know. To this widespread and everpresent abundance of an efficient caterpillar-hunter has been attributed the comparatively low incidence of the cotton worm (*Alabama*) in St. Vincent, when other islands have been severely attacked. Some *e.g.* Ballou, believe that this particular wasp (*Polistes annularis*) is more efficient than the related *Polistes* spp. of the other islands, and following this idea, have introduced the St. Vincent form into some of the Leeward Islands, where its failure has been attributed to the presence of a parasitic moth (*Dicymolomia pegasalis*) said to be absent from St. Vincent. Harland, on the other hand, considers the greater abundance of this and certain other natural enemies of cotton pests in St. Vincent, to be due to the much greater extent of "bush" and uncultivated land in the latter island, as compared with the other cotton islands and especially with Barbados. I believe Harland is right in recognising that it is a question of relative abundance of the St. Vincent Jack Spaniard rather than of its relative efficiency. But if Grenada, St. Lucia and Dominica, are compared with their equally large or even much greater proportion of untilled lands and "bush", it is obvious that his explanation of this abundance is invalid, for *Polistes* wasps are by no means particularly abundant in these three islands. The key to the position lies, I believe, in the arrowroot industry itself, which is largely confined to St. Vincent and is practised, in almost every part of the Island. Since arrowroot fields are replanted at the time of harvesting, and *Calpodes* eggs are laid on new leaves within three weeks of planting (Robinson) there is a practically continued supply of arrowroot worms throughout the year—for the Jack Spaniards a perennial food-supply which is not offered by any other species of caterpillar that I know, at least on any comparative scale. The supply of cotton worms (*Alabama*), for instance, is very much more periodic—restricted to a very few months, and in some years very scanty. The arrowroot worm therefore, I believe, acts as an immense

* There has been much confusion in the identification of this species. It was described by Townsend in 1892 as *Sarcodexia sternodontis*, which was misprinted in Harland's report as *Sariodexia* and repeated as such by Urich. Aldrich (1930) has shown that the correct name is *Sarcophaga lambens*.

reservoir of food for its *Polistes* and is the one single factor which enables it to maintain such an immense population from year to year.

The effect of lizards in eating arrowroot worms needs careful investigation, involving the examination of stomach contents, and the observation of habits in the field.

Mr. Robinson has already shown, by stomach examination, that the blackbirds (*Holoquiscalus*: the specific name is under discussion) feed on *Calpodes*. An examination of 100 pupal leaf folds taken at random, towards the end of an infestation, the traces of pupae eaten by birds being easily distinguished from those which had given rise to butterflies, showed a total pupal mortality of 32 per cent., of which 28 was due to birds. In addition to continued observation of bird-habits in the field, experiments should be undertaken to ascertain the possible value of bird perches of bamboo or other convenient sticks, placed at frequent intervals in the fields. The great importance of wind-breaks and other plantations of trees and bushes, as shelter and breeding-grounds for insectivorous birds should be emphasized.

V. Cotton Insects.

Cotton pests are being combatted in St. Vincent with considerable success by three main methods, namely, rigid close season, destruction of alternate host-plants and breeding of resistant varieties. The last-named having proved very effective against such crytogamic diseases as angular leaf-spot, is now being initiated at the Cotton Experiment Station against insects too.

Cotton stainers (*Dysdercus delauneyi*) were once, and probably still are the worst insect pest of cotton in St. Vincent. I found them numerous on *Thurberia* at the Cotton Station. They are kept down by close season regulations and by the vigorous destruction of alternate hosts. This involves considerable work every year, especially in cutting the new shoots of John Bull tree (*Thespesia populnea*) and trimming such silk-cotton (*Ceiba pentandra*) as are not destroyed. The destruction of the abundant *Sterculia* trees—a favourite host in the rain forest of the higher windward slopes, has been given up as economically impracticable. These, with occasional overlooked hosts, and possibly infringements of the close season and seed-disposal regulations, serve to maintain a by no means inconsiderable stainer population. The only economic means of avoiding this constant menace and saving the appreciable loss which the stainer still inflicts on the industry, is biological control. With the knowledge of a strikingly efficient Tachinid parasite (*Acaulona*) of cotton-stainers in Peru the prospects of biological control are decidedly good, given adequate preliminary study of the host in St. Vincent, and the parasite in Peru.

Much the same remarks apply to the pink bollworm (*Platyedra gossypiella*). Here, as elsewhere, the most important measure of control lies in a rigid close season. There is, however, no reason against, and much promise from a well-thought out scheme of biological control, such as has already been projected for the other cotton islands. It cannot be too strongly emphasised, however that our ignorance of pink bollworm biology under West Indian conditions is profound. Its extraordinary fluctuations in numbers from year to year and from island to island are completely inexplicable from our present knowledge. Any scheme of parasite introduction must be based on the results of two or three years' intensive local ecological research, or it is fore-doomed to failure.

Mole crickets, I am informed by Mr. S. H. Evelyn are among the worst pests of young cotton, and the chief cause of the need for extensive supplying. Here, again, considerable study of the insect is required. I am not aware that it has even ever been identified as to the species.

Cotton aphis (*Aphis gossypii*) is locally and occasionally destructive. I saw several infestations, both on leeward and windward estates. In every case ladybirds were plentiful and evidently doing good work, especially the unspotted red one (*Cycloneda sanguinea*), the spotted species (*Megilla maculata*) being much less abundant. I saw, however, no sign whatever of Hymenopterous parasites of these aphides. Steps should certainly be taken to ascertain whether these are present, with a view to introducing them if they are not.

VI. Banana Pests.

It was not within my instructions to examine banana pests, but I was struck incidently by the apparent absence of the banana-borer (*Cosmopolites sordidus*)—by far the most important pest of this crop. Neither Mr. Briant nor the Banana Instructor, Mr. George Fraser, had seen an infestation. In view of the development of the banana industry, it seemed to me of tremendous importance to ascertain whether the island were really free from banana borer, with a view to taking every possible step to prevent its entry. A hard search, with Mr. Robinson, on the afternoon before I sailed, demonstrated its presence in a village garden at Mesopotamia, but it is certainly a comparatively rare insect in St. Vincent.

VII. Summary.

1. The giant toad (*Bufo marinus*), which has proved its value as a destroyer of agricultural pests on some of the other islands, is not present in St. Vincent. I suggest that it be introduced, *e.g.* from Trinidad.

2. The two sugar-cane moth-borers (*Diatraea saccharalis* and *D. canella*) in St. Vincent infest this crop to the extent of about 48 per cent. of the stalks and eight per cent. of the joints.

3. If and when the industry is extended to larger areas, under estates conditions, the infestation may be expected to increase.

4. Seven different wild grass hosts are known in St. Vincent. Of these four are important as reservoirs of the borer, but they act also as reservoirs of parasites, since in them the borer is much more accessible to these enemies than in cane.

5. Of the three parasites of *Diatraea* found in St. Vincent, none is of much practical importance, and there is a clear field for the importation of either *Lixophaga* or *Paratheresia* (efficient Tachinid parasites), and of a specific parasite, when found, for the yellow-headed borer (*D. canella*).

6. The decision as to *Lixophaga* or *Paratheresia* should be deferred till the results of experiments in Antigua and Barbados are available.

7. The greatest preliminary need in the investigation of the arrowroot worm (*Calpodes ethlius*) is a just estimate based on experiment and expressed in £ per annum, of the loss it inflicts on the industry. Mr. Robinson has already arranged such experiments.

8. A second essential is a thorough study of the natural enemies, more particularly parasites, already attacking the pest in St. Vincent. Special attention should be paid to the Tachinid and Sarcophagid flies, with a view to introducing one or more species from Trinidad, if investigation shows they are not already present.

9. Bound up with the question of parasites is that of alternate host-plants, which should be thoroughly studied with regard to incidence, infestation and parasitism.

10. Jack Spaniards (*Polistes annularis*) are phenomenally abundant in St. Vincent as a result of the large and perennial food reservoir supplied by the arrowroot worm, on which they are very effective predators.

11. Other predators are lizards and birds. Experiments in the encouragement of the latter should be undertaken with bird-perches (bamboo, &c.) posted at frequent intervals in the fields.

12. In spite of rigid close season and destruction of alternate hosts, cotton stainers and pink bollworm are by no means negligible pests in St. Vincent. Both should be the subject of thorough local ecological research as a preliminary to a project of biological control, which is very promising in both cases.

13. An effort should be made to ascertain whether any parasites (as distinct from predators) of the cotton aphis occur, with a view to importing some if they are lacking in St. Vincent.

14. The banana borer (*Cosmopolites sordidus*), is present in St. Vincent but it is at present a comparatively rare insect.

IX. References.

Barbour, T.—1930. A list of Antillean reptiles and amphibians. *Zoologica*, Vol. XI, pp. 61-116.

Hardy, F., Robinson, C. K. and Rodriguez, G.—1934. Studies in West Indian Soils. (VIII)—The agricultural soils of St. Vincent. Imp. Coll. Trop. Agriculture, 43 pp., 1 map.

Myers, J. G.—1931. A preliminary report on an investigation into the biological control of West Indian insect pests. *E.M.B.* 42, 178 pp., 2 maps. *H.M.S.O.*, London.

Urich, F. W.—1932. The arrowroot leaf roller (*Calpodes ethlius*). *Tropical Agriculture*, Vol II, pp. 299-300.

Wright, G.—1929. Economic conditions in St. Vincent, B.W.I. *Econ. Geogr.*, Vol. V, pp. 236-259, 14 figs.

MISCELLANEOUS NOTES.

The Application of Inorganic Fertilizers in Irrigation Water.

The application of inorganic fertilizers in citrus orchards, is usually done by the broadcasting of the fertilizer around the tree. In the California citrus belt some orchards are applying inorganic fertilizers in the irrigation water.

Inorganic fertilizers such as Sodium-Nitrate and Ammonium Sulphate are readily soluble in water, and when applied to the irrigation reservoirs, they dissolve and are carried with the water and thus distributed throughout the orchard.

Large tanks are placed over the main distributing points of the irrigation water, the fertilizer sacks being emptied into these tanks which contain a measured quantity of water. At the bottom of the tank is placed a gauge which allows a small quantity of the dissolved fertilizer to drip into the irrigation pipe.

This method of applying inorganic fertilizers is quite effective, its main advantage being the cheapness of application. Some growers maintain, however, that the distribution of the fertilizer is uneven because it tends to accumulate in certain portions which are of a lower elevation than the main distributing irrigation points.—(*Hadar*, Vol. II, No. 10/11, 1934, p. 253.)

Discolouration in Preserved Latex.

A very valuable discussion of this subject by Edgar Rhodes and K. C. Sekar will be found in the *Journal of the Rubber Research Institute of Malaya* of March, 1934. Extending earlier observations by de Vries, it can be shown that such discolouration can usually be traced to the presence of soluble iron, and the presence of the iron may often be associated with acid production due to fermentative changes with the consequent solution of iron from metal containers. This soluble iron then may react with hydrogen sulphide or other soluble sulphide, the sulphide being produced as a rule by the gradual hydrolysis of the protein material in the latex, a process taking place more readily under alkaline conditions, which may occur as the latex before shipping is usually treated with ammonia. Thus acid production following collection, associated with iron containers, and then sulphide production following ammoniation before shipping, are accessory factors in discolouration. The discussion of this problem may enable grower and shipper to combine to reduce the discolouration in the latex which otherwise makes it unsuitable for many of the new processes in which rubber latex is now being utilised.—(*Nature*, Vol. CXXXIII, No. 3374, 1934, p. 988.)

CITRUS FRUIT-ROTS IN TRINIDAD.

By R. E. D. Baker.
Department of Mycology, Imperial College of Tropical Agriculture.

Introduction.

Hitherto citrus fruit-rots have received little attention in Trinidad, but the recent development of the grapefruit industry makes their investigation desirable. In this industry at present the amount of fruit lost through the agency of fungous rots is small compared with that which has to be 'culled' for other reasons; but oranges, especially the loose skinned varieties, are more readily rotted than grapefruit, particularly if they are held for any length of time in the packing shed. This rotting is mostly due to careless picking and handling of the fruit by the grower, practices which must be modified if this export trade is to flourish. *Botryodiplodia theobromae* (*Diplodia natalensis*), *Penicillium digitatum* and other fungi which cause serious fruit-rots in the United States, South Africa and other countries are present in Trinidad; and it is probable that with the further expansion of the citrus industry preventive measures will have to be adopted against some of them.

The following investigations were carried out during the 1934-1935 grapefruit crop. As far as possible fungous rots from the estates, the packing shed of the Co-operative Citrus Growers Association of Trinidad and Tobago, and the Imperial College Low Temperature Research Station were kept under observation throughout the season. Isolations of the organisms in rotten fruit from these three sources were made at frequent intervals and a full series of inoculation experiments to determine their relative pathogenicity was carried out. (Table I.)

Fruit-Rots in the Field.

During the months of October, November and December when the grapefruit crop had commenced and the rains still continued, many fungous rots were isolated from fallen fruits. It was noted that rotten grapefruit were hardly ever found on the trees unless they had been damaged by some means including insects, birds or cultural implements. The only organisms so far found attacking unwounded grapefruit on the trees are the *Phytophthora* species, but attacks of this nature were seldom observed. The commonest organism isolated from fallen fruit was *Botryodiplodia theobromae*, other fungi including *Phytophthora parasitica*, *Phytophthora palmivora*, *Penicillium digitatum*, *Oospora* sp., *Phomopsis* sp., and *Colletotrichum gloeosporioides* being only occasionally found.

When the dry season commenced in January and February the quantity of rotten fruit diminished considerably. The *Phytophthora* species completely disappeared, probably because water is necessary for the production of their zoospores, which are therefore unable to function in dry weather. *Penicillium digitatum* became slightly more common, but all the other rots including *Botryodiplodia theobromae* decreased.

At present, therefore, it is doubtful whether special precautions are necessary or would be effective against fungous rots in the field. The trimming of low branches recommended in the control of gummosis (1) should eliminate the possibility of *Phtophthora* rot of fruit on the trees since this fungus inhabits the soil and is splashed on to the fruit of low branches only during heavy rain. On some estates fallen fruit is collected and buried at frequent intervals. This practice may be beneficial in districts where there is reason to fear a possible attack of fruit fly, but can be of little value in the control of fungous rots. On no occasion should fallen fruit be sent to the packing shed.

Fruit-Rots in the Packing Shed.

At the beginning of the crop a certain amount of rotten fruit was observed in consignments arriving at the shed. In general, this was caused by *Botryodiplodia theobromae* or *Penicillium digitatum*. In the process of picking and delivering fruit to the packing shed a certain amount of bruising and wounding is inevitable, but every reasonable precaution should be taken to reduce this to a minimum. In picking, the stalk must be cut as close to the fruit as possible, so that no projection capable of damaging other fruit in contact with it in the field boxes is left*. Careful handling is essential at all times to avoid bruising,

* In this connection the following extract from the West India Committee Circular of 28th February, 1935, is of interest, but is of doubtful application to British West Indian conditions: "Another point, perhaps, a minor one as regards cost, but well worth testing out is that to which prominence is given in the Report for 1934 of the Chief of the Bureau of Plant Industry of the United States Department of Agriculture. Under the heading 'Improved Method of Harvesting Grape Fruit' that authority states:—

"The method universally used for the commercial harvesting of citrus fruits is to cut the fruit from the tree by means of clippers. Some clipper cuts occur, and some stems are left so long that they cause injury to other fruits during the process of harvesting, grading and packing. These wounds allow the entry of the blue and green moulds that cause decay. During the year it was found from the Bureau's experiments in Florida that mature grapefruit can be pulled from the tree without injury to the peel, and that fruit so harvested will suffer less from stem end rot in common storage than clipped fruit. Since pulling is faster, and therefore cheaper than clipping, there seems to be good reason for making it the standard practice for grapefruit."

"This may seem almost to savour of a return to the 'bad old days' but coming from such an authoritative source the Bureau's method of harvesting should be carefully tried."

and field boxes should not be overfilled or the fruit will be crushed in transit. Furthermore, freshly picked fruit is more susceptible to bruising than fruit which has been allowed to undergo partial wilting. Experience indicates that a period of twenty-four hours (or more, depending on the season) under cover on the estates prior to transport to the packing shed is advantageous. In addition, to avoid excessive handling, fruit should be picked directly into the field boxes whenever possible. The extra handling necessitated by the practice of picking into cacao baskets and other receptacles and then heaping the fruit on the ground to await despatch may result in excessive damage.

Fruit should never be handled whilst wet; picking operations therefore should not commence until the dew has evaporated, and must be suspended during and for several hours after a fall of rain.

From February onwards, the quantity of rotten fruit arriving at the shed decreased and fungus rots were only observed on fruit which arrived in a damaged condition, or which had been stored in the packing shed for 10 days or over without refrigeration.

Wastage in Storage.

Wastage of grapefruit in storage, other than that due to chilling or desiccation has been referable mainly to *Botryodiplodia theobromae*, *Penicillium digitatum* and *Colletotrichum gloeosporioides*. Other fungi isolated, including *Phomopsis citri*, *Dothiorella ribis*, *Penicillium italicum*, *Eidemia* sp. and *Fusarium* sp. have been of very occasional occurrence.

Of the three principal fruit-rotting organisms, *Botryodiplodia theobromae* with its rapid growth rate at high temperatures is responsible for the early incidence of rotting in these consignments where the non-refrigerated pre-storage period has been unduly prolonged. Thus fruits which have been wounded, inoculated, and held at tropical temperatures for six days will show the disease in a severe form. Similarly in the relatively slow cooling down of bulk consignments to the transport temperature on ship-board, this organism is also able to make rapid inroads, and is responsible for the wastage observed during the first inspection of cases at the port of discharge. High relative humidity in storage rooms would tend to favour the contact spread of this organism by the rapid growth of superficial mycelium. Although all classes of fruits are easily rotted by *Botryodiplodia theobromae* there is evidence that fruits from some localities are worse than others in respect of the incidence of this disease.

Penicillium digitatum may also appear in severe form soon after fruits have been taken into storage. The factors chiefly responsible are bruising or wounding and the profuse distribution of the spores of the fungus. The importance of skin abrasions in raising the incidence of this fruit-rot was well illustrated in a consignment of the loose-skinned but brittle Satsuma orange, where practically all wastage was due to this organism. The prevalence of *Penicillium digitatum* and the comparative absence of *Penicillium italicum* during the current season have been in contrast to previous wastage records.

Colletotrichum gloeosporioides is characteristic of those consignments of fruit which have been kept in storage for a considerable time, or which have been subjected to chilling, desiccation or a combination of both. Turgid freshly picked fruits are therefore not attacked by this organism, even when it is applied through wounds, but it is by far the most serious cause of wastage at the end of prolonged storage trials when fruits may have lost as much as ten per cent. of their original moisture content. A large series of isolations indicates that the organism responsible is of consistent appearance, and unlike certain other types of anthracnose, is apparently not represented by a number of different strains.

It is noteworthy that *Phytophthora* rots have never been found in storage although during wet weather they are frequently met with in the field and the packing shed. It was found that both *Phytophthora parasitica* and *Phytophthora palmivora* are practically incapable of growth at the temperatures at which grapefruit is generally stored for shipment (53°F. or less). This no doubt accounts for the absence of this organism in the cold storage investigations. (Figs. 1 and 2.)

Primary Organisms.

Stem and Stylar-End Rots.

Botryodiplodia theobromae, Pat.
Botryosphaeria ribis, Gros. and Dug. (*Dothiorella ribis*, Gros. and Dug.)
Phomopsis spp. (including *Phomopsis citri*, Fawcett).

Leathery Rots.

Phytophthora parasitica, Dastur (isolated from citrus).
Phytophthora parasitica, Dastur (isolated from cotton).
Phytophthora parasitica, var. *nicotianae* (isolated from tobacco).
Phytophthora palmivora, Butler (isolated from citrus).
Phytophthora palmivora, Butler (isolated from cacao).
Phomopsis species (including *Phomopsis citri*, Fawcett)
Colletotrichum gloeosporioides, Penz.
Fusarium lateritium, Nees. var *fructigenum*,

Soft Rots.

Penicillium digitatum, Sacc.
Penicillium italicum, Wehmer.
Oospora spp. (*Oospora citri-aurantii* (Ferraris) ?)
Aspergillus niger (group) van Tieghem.
Rhizopus nigricans, Ehrenb.

A good description of most of the fungous rots of citrus fruits will be found in 'Citrus Diseases and their Control' by Fawcett and Lee. Under the warm humid conditions of the Trinidad climate certain noteworthy differences in symptoms

Fig I

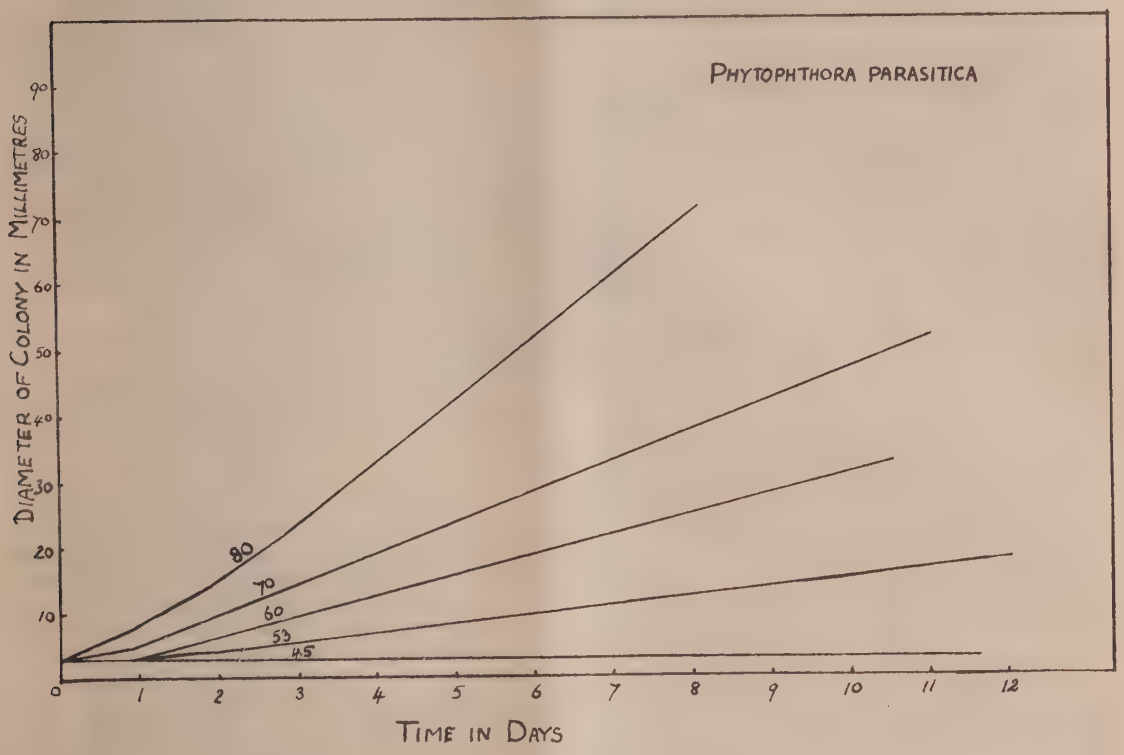
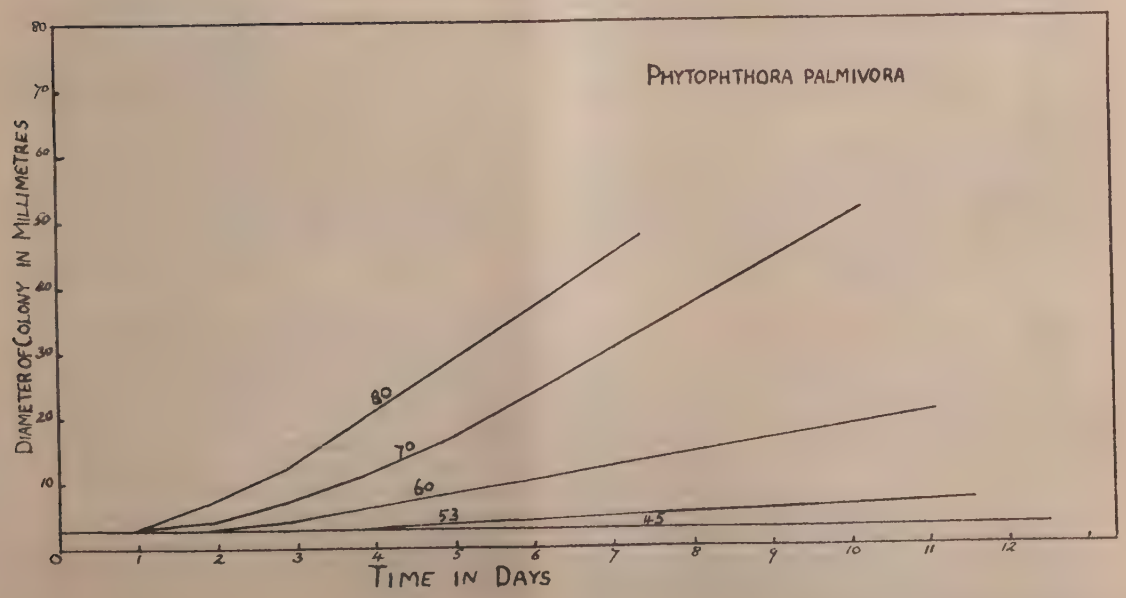

PHYTOPHTHORA PARASITICA
DIAMETER OF COLONY IN MILLIMETRES
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
80
70
60
53
45
TIME IN DAYS

Fig II


PHYTOPHTHORA PALMIVORA
DIAMETER OF COLONY IN MILLIMETRES
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
80
70
60
53
45
TIME IN DAYS

from those described by the above authors are apparent, and it was thought worth while to give a detailed description of the symptoms of some of the fungous rots of grapefruit found in Trinidad.

Botryodiplodia theobromae, Pat.

This organism is a wound parasite and cannot attack healthy unwounded fruit. Inoculation experiments (Tables I and II) have shown that it can enter through bruises, wounds and abrasions of the skin, and through the wound left at the stem end of a fruit after the 'button' has been forcibly removed. Some of these experiments, especially those made with spore suspensions, or with mycelium on bruised or only slightly wounded fruit, gave a lower percentage of successful inoculations than was expected. The humidity relations of the organism are important in this connection, and further research in this direction will probably explain these failures.

The symptoms vary considerably according to the age, ripeness and turgidity of the fruit attacked. A freshly picked, mature, unwilted fruit generally breaks down completely to a soft semi-liquid mass, while a fruit which has been allowed to wilt for some days does not break down in this way and may finally become 'mummified'. In general, the skin of the fruit is water-soaked and is at first a livid light brown colour, but later turning a dark greenish olive and finally black. This colour is due to the dark olivaceous mycelium of the fungus which is also abundant in the core of the fruit. Attacks are generally initiated at or near the stem end, whence the fungus passes rapidly through the fruit to the stylar end, the intermediate area of the skin becoming involved at a later stage. Once it has become established, the fungus spreads with great rapidity at tropical temperatures in the fruit, destroying it in four or five days. The black stromata and pycnidia of the fungus are produced in abundance on the skin of the fruit. The elliptical spores are at first hyaline and unicellular, but later become dark brown and bicellular, $20\text{-}30 \times 14\text{-}18\mu$ ($25 \times 15\mu$) in size.

A similar fruit-rot has been reported from other citrus-growing countries (including the United States, South Africa and Jamaica) to be caused by *Diplodia natalensis*, Evans, an organism similar to and possibly identical with the one under discussion.

Botryosphaeria ribis, Gros. and Dug.

(*Dothiorella ribis* Gros. and Dug.)

The pycnidial (*Dothiorella*) stage has recently been found on grapefruit. It causes a typical stem and stylar end rot almost indistinguishable from that produced by *Botryodiplodia theobromae* except for the colour of the mycelium which is a dark brownish-purple as opposed to the greenish-black of *Botryodiplodia theobromae*. It is slightly slower in its action, taking about six days to infect the whole fruit, which is seldom completely disintegrated. The stromata, pycnidia and spores are produced in abundance on the surface of diseased fruit. The spores are hyaline, unicellular and measure $16\text{-}25\mu \times 4.5\text{-}7.5\mu$. In culture the organism is again almost indistinguishable from *B. theobromae* until the pycnidia are formed. Inoculations with mycelium from a young active potato-sucrose-sugar culture reproduced the disease when the inoculum was placed in wounds, but not on unwounded tissue. (Table I.) This organism was described as the cause of a citrus fruit-rot in the United States in 1924 (2). It appears to be rare in Trinidad, since it has only been seen twice on fruit which had been kept in storage for some time.

Phytophthora parasitica, Dastur, isolated from citrus.

Phytophthora parasitica, Dastur, isolated from cotton.

Phytophthora palmivora, Butler, isolated from cacao.

Phytophthora palmivora, Butler, isolated from citrus.

Phytophthora parasitica, var. *nicotianae*, isolated from tobacco.

These five organisms produce fruit-rots of grapefruit and other citrus fruit, the symptoms of which are indistinguishable, and will therefore be discussed together. Only two of the above have been isolated from citrus fruits; but the pathogenicity of the other three to citrus was demonstrated by inoculation. The two 'citrus' and the 'cacao' isolations are capable of producing infection not only through wounds but also directly through the unwounded cuticle. These three organisms are the only fungi at present known in Trinidad to be capable of producing a rot of unwounded citrus fruit. The lesion produced is firm, leathery, usually slightly sunken, and light brown to purple-brown in colour. The skin is not watersoaked and in general the affected tissue is tougher and more leathery than the uninfected. Under moist conditions all five (*P. parasitica* less readily than the others) produce a mass of white mycelium and sporangia on the surface of the fruit. The fruit is never completely broken down by the *Phytophthora* sp., but secondary organisms may follow fairly closely behind it and complete the destruction. Fruit attacked by *Phytophthora* species develop a peculiar pungent smell and have an exceedingly unpleasant bitter 'quinine' flavour.

It has been demonstrated by inoculation (Table II) that three of these organisms can attack a great variety of citrus fruits, when the inoculum used is mycelium from a young and active potato-agar culture, placed in a wound. There may be some slight difference in susceptibility of the various fruits tested to these three organisms, but in general most citrus fruits appear to be susceptible.

Fruit-rots of grapefruit caused by the two *Phytophthora* species isolated from citrus fruit are fairly common in the wet season, but with the onset of dry weather they become negligible as sources of wastage.

Phomopsis spp. (including *P. citri*, Fawcett).

Phomopsis species may occasionally be obtained from rotten grapefruit in the field, the packing shed and the cold store. They are generally isolated from brown leathery sunken lesions at or near the stem end of old or wilted fruit. Inoculations made with mycelium or a spore suspension into healthy unwilted fruit produced a rapid stem and stylar end rot practically indistinguishable from *Botryodiplodia* stem end rot in its early stages. No dark greenish-black colour develops in the later stage, but the fruit remains a livid brown colour until it breaks down. This severe type of *Phomopsis* rot has never been seen in the field or in the packing shed; the mycological evidence, which is admittedly incomplete, suggests that depth of wounding prior to inoculation is probably an important factor. Inoculations made on wilted fruit that had been several weeks in cold storage produced the typical leathery type of rot.

Penicillium digitatum, Sacc.

The common green mould is, after *Botryodiplodia*, the most prevalent rot of grapefruit. It also is a wound parasite but, once it has gained entry it causes rapid destruction of fruit. The symptoms of this well-known fruit-rot have been described many times, and a good description is given by Fawcett (2). The lesion is watersoaked, soft, and at first not discoloured. It enlarges rapidly, sometimes becoming sunken, and a growth of white mycelium and finally a powdery mass of green spores appear on the surface. The entire fruit is soon involved and is reduced to a soft mass covered with the green spores of the fungus. Grapefruit at all stages of maturity provided they are full, can readily be infected with this rot.

Penicillium italicum, Wehmer.

The blue contact mould is fairly common and is generally found in association with *Penicillium digitatum*. It also is a wound parasite but is not nearly so rapid in its action as *P. digitatum*. In the current season, wastage due to this fungus has been negligible, and all inoculations made with fresh isolations of the organism have failed to produce any appreciable rotting of grapefruit. It is possible that this may be correlated with some unexplained peculiarity of season or environmental conditions.

Oospora sp. [possibly *O. citri-aurantii*, (Ferraris).]

A very soft watery rot is sometimes found following wounds in the wet season. The rotten area is a pale creamy yellow in colour, very soft and watersoaked and full of the spores of the fungus. The fruit finally collapses to a semi-liquid mass. This type of rot is seldom encountered anywhere except in the field during wet weather. Fawcett and Lee (2) describe a soft rot of citrus fruit caused by *Oospora citri-aurantii* which is probably identical with the fungus under consideration. Inoculation experiments demonstrated that it is capable of attacking wounded grapefruit. (Table I).

Colletotrichum gloeosporioides, Penz.

Isolations of this organism have been obtained from a variety of lesions on grapefruit in the field, the packing shed and the cold store. The usual type of lesion is a firm, dark-brown leathery, sunken one, indistinguishable from that caused by *Phomopsis* on an old wilted fruit. Strains of this fungus have also been obtained from softer watersoaked lesions of a peculiar ashen-grey colour. If such a fruit is cut open it will generally show a peculiar light pinkish colouration in the affected rind, extending also into the pulp, affording a characteristic symptom of this type of rot. When the rot has become firmly established in the fruit, conidia are abundantly produced in pinkish acervuli on the outside, and furnish a ready means of identification.

Fawcett (2) states that 'the anthracnose fungus, *Colletotrichum gloeosporioides* may under certain conditions produce a soft pliable rot usually in very mature, or over-ripe fruit. Most of the strains of the anthracnose fungus are unable to cause rotting in strong fresh vigorous fruit. Anthracnose decay has been readily produced on mature fruit by inoculation in the laboratory'. Results obtained in Trinidad agree with the above statement, as inoculations of fresh fruit invariably failed and typical lesions were produced on old wilted fruit. (Table I.)

Aspergillus niger (group) van Tieghem.

Isolations of this organism from soft rots in the packing shed were occasionally obtained. The rot is very soft, sunken and watersoaked, and the skin can be broken by a light pressure with the finger. The rotted area is not discoloured, but is only slightly darkened due to the watersoaking of the skin. At a later stage the conidia of the fungus are produced abundantly on the rotted tissue. Infections of this nature are easily obtained by inoculation.

Rhizopus nigricans, Ehrenb.

This fungus produces a rot very similar to that of *Aspergillus niger*, being soft, watersoaked, sunken, and not discoloured. If the skin is broken, a grey felty mass of sporangia is produced. *Rhizopus nigricans* is a wound parasite and has only occasionally been met with in the packing shed. Here again the typical soft rot symptoms are readily reproduced by inoculation.

Fusarium lateritium, Nees. var *fructigenum*, Fries.

Lesions closely resembling those of *Colletotrichum gloeosporioides* occasionally gave isolations of this organism. These lesions were somewhat variable, but generally dark brown in colour, leathery and sunken. Occasionally the centre of the lesion became softer and watersoaked. On cutting open the fruit, considerable internal breakdown and a generalised brownish-pink discolouration of the tissue is evident. Without making isolations it is difficult to say whether lesions of this type are produced by the above fungus or by *Colletotrichum gloeosporioides*.

TABLE I.

Inoculation of 'Marsh' grapefruit with various organisms. Inoculum. Mycelium from young potato-sucrose-agar cultures. Fresh ripe fruit was used throughout the experiment with the exception of series 13, 17 and 24.

Organism.	Type of Inoculation.	Percentage success.	Remarks.	Approx. time for complete breakdown of fruit.	Reisolation.
1 *Botryodiplodia theobromae* (citrus)	In wounds	100	Rapidly produced watersoaked rot	4 to 5 days	yes
2 do. do.	No wounds	0	No infection	—	—
3 do. do.	On bruises	33	As (1)	4 to 5 days	—
4 do. do.	On abrasions	75	As (1)	4 to 5 days	yes
5 do. do.	At stem end after forcible removal of 'button'	25	As (1)	4 to 5 days	—
6 *Botryodiplodia theobromae* (avocado pear)	In wounds	100	As (1)	4 to 5 days	yes
7 *Botryosphaeria ribis* (citrus)	do.	100	Very similar to *Botryodiplodia* except for slight colour difference and slower rate of growth	6 days	yes
8 do. do.	No wounds	0	No infection	—	—
9 *Botryosphaeria ribis* (avo. pear)	In wounds	100	Similar to (7)	6 days	yes
10 *Phomopsis* sp. (grapefruit)	do.	100	Indistinguishable soft watersoaked stem and stylar end rots	8 days	yes
11 *Phomopsis* sp. (orange)	do.	100		8 days	yes
12 *Phomopsis* sp. (avocado pear)	do.	100		8 days	yes
13 *Phomopsis* sp. (grapefruit)	In wounds on fruit wilted after one month's storage	100	A much firmer leathery type of rot	about 14 days	yes
14 *Phytophthora parasitica* (citrus)	In wounds	100	The symptoms produced on 'Marsh' grapefruit by all five *Phytophthora* strains are indistinguishable	at least 14 days....	yes
15 do. do.	At stem end after forcible removal of 'button'	75		at least 14 days....	yes
16 do. do.	No wounds	25		at least 14 days....	—
17 do. do.	In wounds on green immature fruit	100		at least 14 days....	yes
18 *Phytophthora parasitica* (cotton)	In wounds	100		at least 14 days....	yes
19 *Phytophthora parasitica* var. *nicotiana* (tobacco)	do.	100		at least 14 days....	yes
20 *Phytophthora palmivora* (citrus)	do.	100		at least 14 days....	yes
21 do. do.	No wounds	33		at least 14 days....	—
22 *Phytophthora palmivora* (cacao)	In wounds	100		at least 14 days....	yes
23 *Colletotrichum gloeosporioides* (citrus)	In wounds	0	No infection	—	—
24 do. do.	In wounds on old wilted fruit	50	Brown leathery rot produced very slowly	Over one month	—
25 *Colletotrichum gloeosporioides* (avocado)	In wounds	0	No infection	—	—
26 *Penicillium digitatum* (citrus)	do.	100	Soft rot	About 10 days	yes
27 *Penicillium italicum* strain (citrus)	do.	0	Result not in agreement with previous work with this organism	—	—
28 *Oospora* sp. (citrus)	do.	50	Soft rot	About 14 days	yes
29 *Aspergillus niger* (citrus)	do.	100	Soft rot	About 14 days	yes
30 *Aspergillus glaucus* (citrus)	do.	0	No infection	—	—
31 *Rhizopus nigricans* (citrus)	do.	75	Soft rot	About 14 days	yes
32 *Fusarium lateritium* (citrus)	do.	75	Dark brown, soft, watersoaked areas spreading very slowly	Very slow	yes
33 *Fusarium roseum* (citrus)	do.	0	No infection	—	—
34 *Fusarium moniliforme* (citrus)	do.	0	No infection	—	—
35 *Trichoderma lignorum* (citrus)....	do.	0	No infection	—	—
36 *Pseudoplea trifolii* (citrus)	do.	0	No infection	—	—
37 *Mucor* sp. (citrus)	do.	0	No infection	—	—
38 *Pestalozzia leprogena* (citrus)	do.	0	No infection	—	—

TABLE II.

Inoculation of 'Marsh' grapefruit with various organisms. Using spore suspensions.

Organism.	Type of Inoculation.	Per centage success.	Remarks.	Approx. time in days for complete breakdown of fruit.	Reisolation.
Botryodiplodia theobromae (citrus)	In wounds	75	In every instance infection was invariably less easy to bring about than was expected. The method of entry of these organisms into fruit in nature is yet to be explained	6 days	yes
do. do.	No wounds	0		—	—
do. do.	At stem end after forcible removal of 'button'.	25		—	—
Phomopsis sp. (grapefruit)	In wounds	62		At least 10 days	yes
do. do.	No wounds	0		—	—
do. do.	At stem end after forcible removal of 'button'	0		—	—

TABLE III.

Inoculation of various citrus fruits with three strains of Phytophthora. Inoculum. Mycelium from young potato-sucrose-agar cultures.

Type of fruit	Type of inoculation.	Percentage Success.			Reisolation.
		1 *Phytophthora palmivora* (cacao).	2 *Phytophthora palmivora* (citrus).	3 *Phytophthora parasitica* (citrus).	
Grapefruit, 'Marsh'	In wounds	100	100	100	1, 2, 3,
do. do.	No wounds	—	33	25	2,
do. 'Duncan'	In wounds	—	100	100	2, 3,
Lemon, 'Sicilian'	do.	—	100	100	2, 3,
do. 'Meyer's Chinese'	do.	—	100	100	2, 3,
do. Rough	do.	100	100	100	1, 3,
do. Rough	No wounds	0	33	0	—
do. 'Ponderosa'	In wounds	100	100	100	1, 3,
Orange, Sour	do.	100	100	100	2,
do. King	do.	100	100	100	2, 3,
do. Satsuma	do.	100	100	100	1, 2,
do. Washington Navel	do.	33	33	100	2, 3,
do. Valencia	do.	0	33	66	3,
Lime, Rangpur	do.	100	100	100	1,
do. East Indian....	do.	0	100	33	3,
do. West Indian	do.	0	100	100	3,
do. Philippine	do.	33	100	100	2, 3,
do. Kusai	do.	100	100	100	1, 2,
do. T. 1.	do.	33	100	100	3,
Citron	do.	100	100	100	2,
Shaddock	do.	0	100	100	2, 3,
Citrus excelsa	do.	100	100	100	1, 2, 3,
Meraviglia mammillata	do.	100	100	100	2,

Inoculations showed that this organism was capable of rotting grapefruit, but that it spreads very slowly even in old over-ripe fruit.

Secondary Organisms.

Fusarium roseum (group).
Trichoderma lignorum, Tode.
Pseudoplea trifolii, (Rostr.) Petrak.
Aspergillus glaucus (group) Link.
Mucor sp.
Pestalozzia leprogena.
Eidemia sp.
Fusarium moniliforme, var. *subglutinans.*

The above fungi are found in a secondary capacity only on rotten areas produced by the primary fruit-rotting organisms described in the previous section. Inoculation experiments showed that none of these organisms were capable of causing a primary rot of fresh grapefruit, but there is no doubt that in many instances they complete the breakdown of a fruit attacked in the first place by one of the primary fruit-rotting organisms.

Trichoderma lignorum is recorded as the cause of a minor citrus fruit-rot in other countries. In Trinidad, however, primary rots caused by this organism have not been observed, and all inoculation experiments have given negative results.

Stylar End Rot (Cause unknown, probably physiological).

Fruit with a small sharply delimited brown, sunken area at the stylar end were occasionally seen both in the field and at the packing shed. The brown area extends into the rind, which has a collapsed appearance, and occasionally a short distance down the core of the fruit. It is seldom over a centimetre in diameter and does not appear to increase in size even when the fruit is kept in a damp atmosphere at tropical temperatures for over three weeks. Isolations from these lesions yielded no fruit-rotting organism, but only occasional cultures of fungi (usually *Fusarium roseum*) which were demonstrated by inoculation to be purely secondary. It appears probable therefore that this blemish on the fruit is due to some physiological trouble. This view is supported by the fact that fruit of this type are not found scattered throughout all the trees on an estate, but in fairly large quantities on a few trees only. These trees appear normal and are not more seriously attacked by gummosis than other trees on the estate. The cause of the trouble is at present unknown. Similar troubles have been reported from other countries. Fawcett (2) describes a stylar end rot of Persian limes and lemons in Florida, California and Cuba. He records the presence of *Colletotrichum gloeosporioides* in fruit from Cuba and Florida, but states that it is probably a secondary agent in producing decay. The results obtained with the stylar end rot of grapefruit in Trinidad agree with this conclusion.

Explanation of Tables.

In Tables I and II the word in parenthesis after the name of the organism (col. 1.) indicates the host from which the culture was originally obtained.

The following technique was used for all inoculations.

The fruit was washed with methylated spirit, and small wounds made with a sterile scalpel inoculated with mycelium from a fresh potato-sucrose-agar culture. The fruits were stored over water in desiccators for 24 hours, and then placed on a bench in the laboratory.

This technique was suitably modified for making inoculations without wounds, or using a spore suspension as the inoculum. When no wound was made, the fruits were stored over water in desiccators for the duration of the experiment.

Acknowledgment.

The author wishes to record his thanks to the Co-operative Citrus Growers' Association of Trinidad and Tobago for providing the grapefruit used in these experiments.

References.

(1) Baker, R. E. D.—" Gummosis of Citrus in Trinidad. I." *Tropical Agriculture*, Vol. XI, No. 9, pp. 236-239, 1934.
(2) Fawcett, H. S. and Lee, H. A.—" Citrus Diseases and their Control." 1926.

RUBBER STRIPS.

The Use of Rubber Strips in Budding Fruit Trees.

R. J. Garner.

Trials to compare the relative values of rubber strips and raffia for tying buds are described. Ten plots each of 20 apple stocks, No. IX (Jaune de Metz) so disposed as to eliminate soil differences, were used for each method. All 400 trees were budded the same day by the same budder with Cox's Orange Pippin. The rubber strips were from 4 to 6 inches in length, three-sixteenths to five-sixteenths inches in width and capable of being stretched to a length of 3 feet without breaking. The cost of the strips was 5*s.* per thousand. The cost of 1,000 ties of raffia including pulling was 3*s.* 6*d.*, but 99 raffia buds out of 200 needed re-tying owing to breakages within 21 days. The speed was about the same in both methods. The result showed a 92 per cent. success with rubber and 79 per cent. with raffia, but it is remarked that this is only a first trial, and that others are in progress. The use of rubber strips is a common practice in American horticulture. It is claimed that with these ties the danger of their constriction in the neighbourhood of the bud in the case of neglected trees and the labour of re-tying or removal of the tie are eliminated.—(*Imperial Agricultural Bureaux, Hort. Abs.*, Vol. III, No. 3, Ab. 290.)

AGRICULTURAL LABOUR IN TRINIDAD.—*Continued.*

By C. Y. Shephard.

Part V.—Remedial Measures.

Introductory.

A striking feature of the labour situation is the fact that the shortage is confined almost entirely to agriculture. Labourers far in excess of the number required can readily be obtained by the oil and asphalt industries, and large numbers of casual labourers are almost always available in the towns. This is largely due to the fact that these occupations are not connected with agriculture, and that the rates of wages are higher than those paid on the estates. Trinidadians, as already noted, are averse to agricultural occupations, and prefer the urbanised life of the oil and asphalt industries or the towns. Here they earn and spend more than estate labourers. A higher rate of wages would probably assist in solving the agricultural labour problem.

The attraction of higher rates of wages is powerfully reinforced in the oil and asphalt industries by the great irregularity of employment. The Public Works Department, whose demand for labour in the country districts is irregular, experiences no difficulty in securing an adequate supply drawn from the neighbouring estates, except during the crop season when the labourers are afforded the opportunity of earning high wages. Agricultural industries are unable, under present circumstances, to pay higher rates. Few sugar estates have paid a dividend during the past eight years, while many cacao estates are still experiencing a difficulty in meeting the interest charges upon their mortgages. A rise in wages from say 45 cents a day to 60 cents, which would approximate to the wages of competing industries, would increase the costs of sugar production by ten per cent., and cacao costs by 20 per cent. It is therefore to greater regularity of employment that agriculture must turn, in order to increase the earnings of the labourers to compete with other industries. Male labourers work on an average 200 days, and earn $100, per annum. If work could be provided, and accepted, on 250 days per annum, the income of a labourer at the same rate of wages would be $125 per annum or, 25 per cent. higher. Opportunity, however, is not the only factor restricting the number of working days, nor can employment be offered so regularly. Both sugar and cacao require the elastic supply of labour under which they were developed in Trinidad, and calculated means of affording employment for all the available labourers at all times of the year have not yet been evolved.

The Sugar Industry.*

Sugar cane has been cultivated in Trinidad with rotation of soil, but without rotation of crop, for nearly 150 years. This is characteristic of nearly all sugar producing areas, the chief exceptions being Java, and, on a smaller scale, Barbados. Both countries are densely populated and cane is not generally ratooned, but is rotated with food crops. Unlike short period annual crops, a large proportion of the sugar estate land in Trinidad is always under cane, so that some cultural operation can advantageously be performed at any time of the year, though the labour requirements of different operations vary considerably. The reaping season, laborious with most crops, is complicated by the fact that the cane must immediately be manufactured into sugar. The period of manufacture is limited by considerations of cane yield, sucrose content, purity of the cane juice, labour supply, and other factors, but primarily, in Trinidad, by transport difficulties. The earthen tracks, which serve as feeders to the railway, are passable only in dry weather so that the crop is limited to the dry season. The crop season demands, superimposed upon the ordinary cultural operations of that period, tend to produce the shortage of labour we have already noted.

Developments in manufacturing processes have changed the nature and intensity of the crop season labour shortage. The smaller cost of manufacture in large central factories has increased the area of cane supply for each factory, and emphasized the importance of transport facilities. The manufacturing processes, formerly very laborious, are now performed almost entirely by machinery, so that there has been a very large reduction in the labourers employed in the factory, and only a slight increase in the numbers employed in transporting cane. In spite of the relief afforded by these developments there still remains a shortage during the reaping season. Further relief might be afforded by transferring operations to other periods when the supply of labour is more adequate; by augmenting, or improving the efficiency of the labour supply; or by the introduction of labour-saving devices.

Cultural operations during the crop season are already reduced to a minimum. On a group of eight estates, S.M.S. 10-17*, an average of only 18,861 units of labour were employed four-weekly on cultural operations during the crop season, compared with 47,713 units during the remainder of the twelve months (July 1927 to June 1928). Planting is brought practically to a standstill. On the same estates, only 1,498 units were employed four-weekly in preparing the land and planting cane during the crop season, compared with an average of 9,527 during other periods. Very little additional relief can be expected by

* Considerable development has taken place, since this article was written, in mechanical cultivation, the use of artificial manures, the use of buffaloes for cartage, and the production of milk and pen manure.

* These estates produce approximately 40 per cent. of the island's sugar. For seasonal distribution of the principal operations see Fig. 10.

neglecting other cultural operations during the dry season; indeed, were it possible, more attention should be paid to the cultivation of ratoon and plant canes.

Cutting and delivering cane to the railway trucks absorbs an average of 41,882 units of labour during the crop season and none during the remainder of the year. At the commencement of the crop, when the farmers are not cutting their own cane, they are available as cane cutters on the estates. But the estates maintain only sufficient animal transport to deliver their own cane at an even rate during the crop season. Since some 35 per cent. of the available mule days, and 55 per cent. of the oxen days, are lost on account of the lack of suitable work, they are expensive as work units. The cost of augmenting their numbers to enable the estates to increase their deliveries of cane by about 80 per cent. during the opening and closing weeks of crop would be prohibitive. Many of the farmers possess animals and carts for the delivery of their own cane, and since these are not engaged at the beginning of the crop, it has recently become the custom for the estates to hire them to transport estate cane *. This affords the peasants profitable employment and supplements the supply of estate labour.

As the reaping season advances, the farmers' carts are withdrawn from the estates to deal with their own cane. Thus, while the estate cane deliveries decrease, those of the cane-farmers increase, and this tends to equalise deliveries throughout the crop. As the farmers complete their reaping, the estates again become mainly responsible for the delivery of cane to the factory. The farmers are unwilling to cart cane for the estates as the payment they have received for their crop enables them to attend to the cultivation of their plots. Cane deliveries tend to diminish, and cultivation on the estates is further delayed. Closer control over the farmers might ensure that they would continue reaping until the end of the season, but their scattered holdings and small quantities of cane, coupled with the possibility of an abrupt termination of manufacture by the advent of the wet season, make such control difficult and dangerous. Special inducements, the cost of which might be prohibitive, might encourage the farmers to cart cane for the estates. While the supply of estate labour can be supplemented at the commencement of crop by hiring farmers' carts, it is difficult to do so towards the end of crop.

To obtain a twelve months' crop and to take advantage of the cheap planting material available, farmers generally plant during the crop season† when labour is urgently required on the estates. The fortnightly payment for canes enables the farmers to absent themselves from the estates, and, in years of high yields,* to employ labour to assist. Measures influencing farmers to plant in the wet season would release labour for the estates. Whole canes, instead of top joints which are useless for sugar production, have to be used as planting material during the wet season. In spite of its high cost, this material is offered by some estates at a nominal price, but this encouragement meets with little response. Until recently, farmers could be ejected at short notice, and without compensation, from estate land. Recent measures for the payment of compensation should increase the security of the farmer and stimulate wet-season planting. Judicious advances of money after the crop might further assist. These encouragements may, in combination, persuade some farmers to alter their planting season, but the relief afforded will probably remain small. The effectiveness of these measures as a means of reducing the crop labour shortage has already been tested and, in some directions, exhausted, and while small additional relief may be anticipated, more effective measures are essential.

During the crop season over 70 per cent. of the total labour units are engaged in cutting cane, delivering it to the factory, and manufacturing it into sugar. Cutting absorbs 11 per cent., loading nine per cent., and carting 18 per cent., of the total units, and any labour saving device which could be utilised for these purposes would bring relief at a period when it is most urgently required. No mechanical cane cutter which can cut the cane flush with the ground, strip the trash or dry leaves, and cut off the green top and immature joints, has yet been invented. The uneven surface of the soil, the recumbent habit of the canes, and the varying length of mature canes, make it appear unlikely that a machine could completely replace human judgment, though it might efficiently perform parts of the reaping operation.

The carting of cane from the field to the railway appears to offer the greatest scope for labour economy. Animal cartage has many disadvantages. Each cart requires one or more animals and a driver, which remain idle while the cart is being loaded in the field, and unloaded at the railway derrick. Congestion frequently occurs in the field and at the railway, and a considerable portion of the day is spent in idleness. The animals are relatively inelastic as power units since they tire rapidly over the rough roads, and are useless after a period of heavy rain has soaked the fields and traces. Considerable and increasing difficulty is being experienced in securing an adequate number of suitable carters.

* See Figs. 8 and 9.

† In some areas the nature of the soil renders this impossible. *e.g.*, N.P.S. 3. This considerably relieves the labour situation on the estate.

* A first payment of $2.88 per ton of cane is made irrespective of the price of sugar. Any balance due is usually paid in July after calculating the average price of sugar for the period January to June since it is upon this average that the price of farmers' cane is based. At this period of the year, yield is the principal factor affecting payments to farmers.

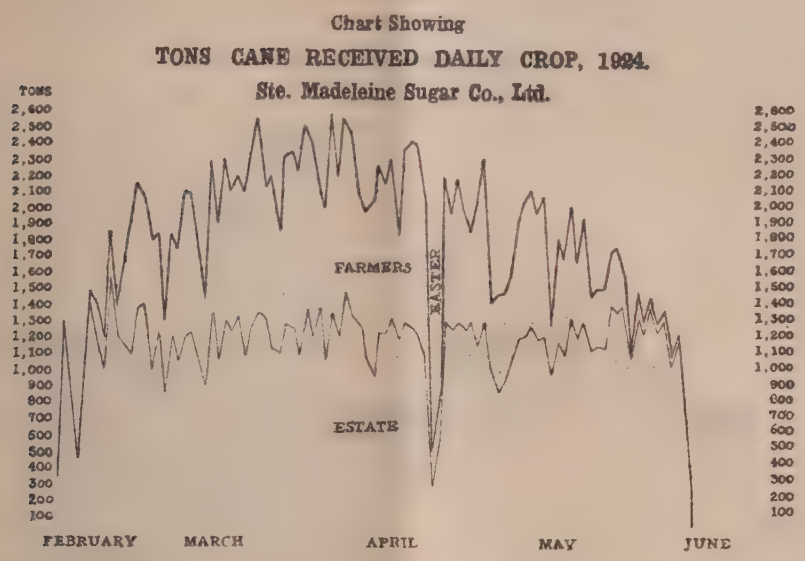


FIG. 8.—The delivery of estate cane, although subject to daily fluctuations, remains relatively regular throughout the season. The delivery of farmers' canes is irregular, being low at the commencement and end of the crop season.

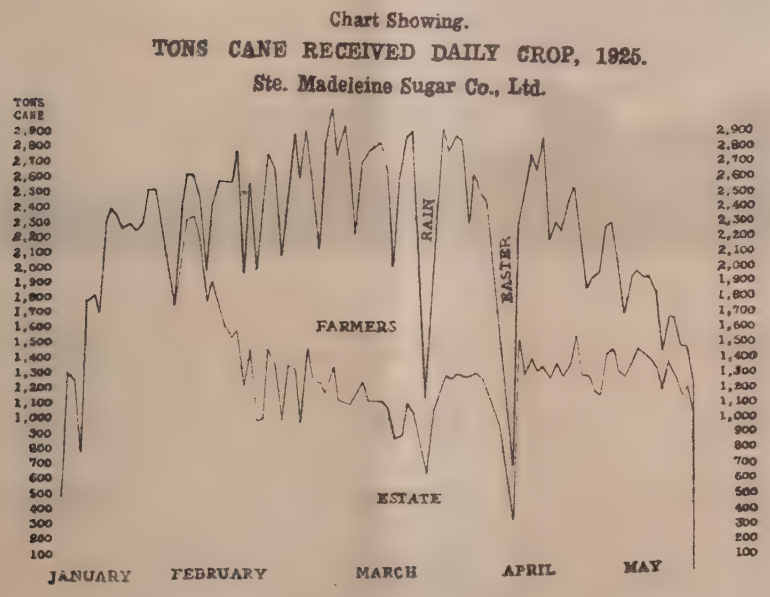


FIG. 9.—During this year farmers' carts were hired for the transportation of estate cane at the commencement of crop, with the result that deliveries were higher than in 1924. Few farmers could be persuaded to cart estate cane towards the end of crop so that deliveries fell rapidly.

LABOUR UNITS EMPLOYED FOUR WEEKLY.

Expressed as percentages of the average four weekly units for the whole period.

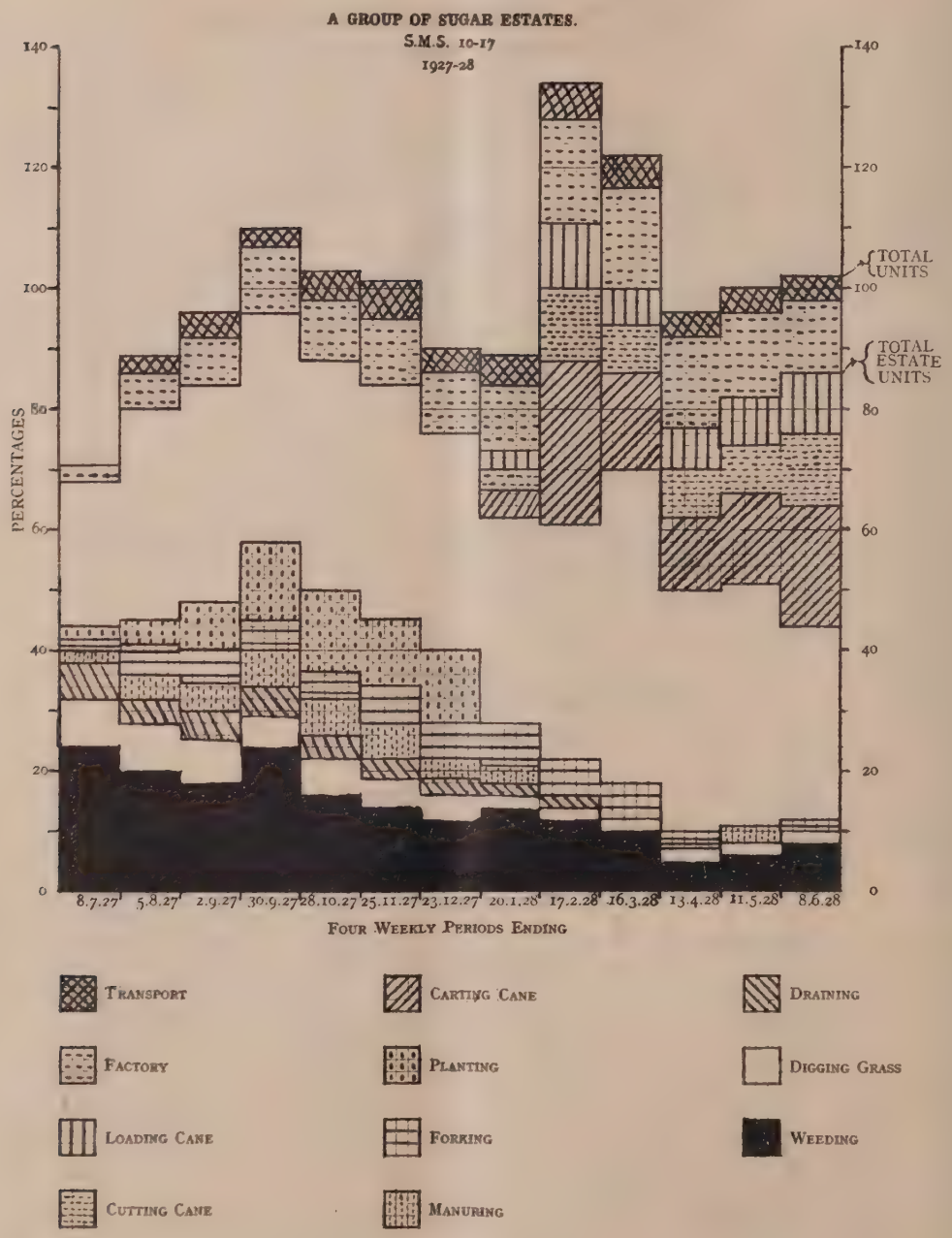


FIG 10.—The blank space is composed of numerous operations individually too small to be detailed in the diagram. In general they are connected with reaping during the crop season and cultivation during the remainder of the year.

Tractor drawn cane-carts offer many advantages. Each tractor can draw a fleet of carts and release a large number of drivers. They travel faster than animals, and are not subject to fatigue, while their caterpillar tracks and reserve power enable them to operate under conditions impossible for animals. West Indian tractor drivers can readily be obtained without seriously interfering with the existing supply of labour. Tractors offer a more elastic means of cane-carting which would reduce considerably the numbers employed in cane-carting.

Several obstacles, however, prevent the immediate adoption of mechanical cartage. Animal drawn carts can be moved, as required, to the positions at which loading and unloading can be performed most expeditiously and economically. Tractors would be robbed of their greatest advantages if they were compelled to wait while loading and unloading took place. An independent power unit must therefore be maintained in the field and at the railway loading station. Animals, used for the purpose of moving the carts as the cutters advance, would seriously restrict the size of the cane-cart. An animal unit would probably be required for each cart being loaded. A mechanically operated crane mounted on a caterpillar motor vehicle offers a possible solution. The cane could be roughly bundled by the cutters and carried by the crane to the carts. This would considerably reduce the number of loaders required. A similar crane should be able to load cane from stationary carts into the railway trucks.

Important reactions upon other aspects of estate organisation would follow. Many expensive animals might be dispensed with. Each animal, however, produces an average of 14 tons of pen manure per annum, so that supplementary sources of manure would be necessary. Mules, which are expensive to maintain, and less valuable than cattle for manure production, are principally used for cane-carting* so that their numbers would be greatly diminished. Cattle, which are less expensive to maintain, might be used solely for the production of manure, which function might, however, profitably be combined with milk production. Trinidad annually imports condensed milk to the value of £100,000, and milk products, or their substitutes to the value of over £100,000. The sale of milk either fresh or tinned†, should meet the expenses of maintaining the herd, and enable the manure to be obtained free of cost.

Artificial manures are not extensively used but experiments suggest that, on certain soils, their application results in a significant and profitable increase in yield. Synthetic methods of manufacturing pen manure require ample supplies of vegetable matter and water, both of which are available in Trinidad during the wet season. Leguminous cover crops, which are now extensively grown, and lime, a necessary preliminary to soil amelioration, should further economise the use of pen manure.

A further obstacle to the use of tractors for cane-carting lies in the fact that petrol costs, wholesale, 38 cents per gallon delivered to the pump. The excise tax amounts to 12 cents and an attempt is being made to secure exemption for petrol used for agricultural purposes. Crude oil can be obtained at less than ten cents per gallon but, without important modifications in engine design the weight of Diesel engines would be so great, in relation to power developed, that such tractors would prove unsuitable. Power alcohol might be manufactured from molasses, provided a denaturant could be devised which would enable it to be exempted from the heavy tax on alcohol. A considerable reduction in the labour requirements of the crop season may be anticipated as mechanical cane haulage is introduced.

An attempt by estates to rectify the cultural deficiencies immediately after the termination of the crop is hindered by the fact that the cane-farmers are similarly engaged. The diminution in supply depends largely upon the financial results of the crop, and may continue into July if the deferred payment on canes is a large one. The mechanical haulage of cane should, however, reduce the cultural deficiencies of the reaping season. Normally the supply of labour improves during July, but is seriously diminished during August, and this retards the preparations for cane planting. On the plains, preparation for planting has long been carried on during the dry season by means of steam cable ploughs. The undulating and heavy nature of the soil in the Naparimas made such preparation impossible either by cable or animal drawn ploughs. The recent introduction of 60 H.P. Caterpillar tractors has enabled estates in this district to plough, or chisel the land, make and form the beds, and partially prepare the cane drills. This work had formerly to be done by hand in the wet season, so that a considerable saving in labour is effected, and the delay in planting made less important. There would be a small additional demand for labour during the dry season, to work the mechanically drawn implements, but the supply would not be drawn from the same source as field labourers. No serious shortage of labour is now experienced during the planting season.

Except for cultivating the recently planted canes, little work can be done on the estates during the period from November to January. Rice reaping affords profitable employment for some, but there is normally a supply of labour surplus to estate requirements. The introduction of another crop or occupation which would absorb this surplus of labour, would facilitate the provision of regular employment.

* Among mules, 18 per cent. of the available days, or 28 per cent. of the days worked, are used for cane-carting, while among oxen the percentages are six and ten respectively.

† The problem of distributing fresh milk to small and irregular purchasers is a great obstacle. Condensed milk would probably have to be produced. Cheap sugar is available from the factory.

WEST INDIAN ENTOMOLOGICAL NOTES.*

By Harold E. Box, F.R.E.S.

(*Entomologist, Advisory Department, Imperial College of Tropical Agriculture.*)

ST. LUCIA.

The Sugar-cane Moth Borers.

I.—*Diatraea canella* Hamps.

Evidence has been secured that this species is essentially a pest of ratoon canes under St. Lucia conditions. Investigations have also shown that, other factors being equal, the abundance of *D. canella* in the fields varies directly with the annual rainfall by districts. The effective control of this borer, which is also a serious pest of sugar-cane in Trinidad and British Guiana, is pending the discovery and exploitation of a suitable specific parasite.

II.—*Diatraea saccharalis* (Fabr.).

This species is the most important pest of plant canes in St. Lucia and in ratoons in the districts of low rainfall. Against it, the Cuban parasite *Lixophaga diatraeae* was introduced from Antigua in August, 1933. During the rearing campaign which occupied four months, fertile female flies were distributed to each of the four principal valleys where sugar-cane is cultivated. A detailed survey of these areas was made during August-September, 1934, with the following results :—

Cul-de-Sac.—Separate colonies of *Lixophaga* found established at several points, but the parasite nowhere abundant. The maximum parasitism in any one field was 9.3 per cent.

Roseau.—Though numerous recoveries were made shortly after the initial liberations, and early establishment was rapid, there was no evidence of the presence of *Lixophaga* in the canefields in August-September, 1934. It was therefore decided to introduce the Amazon Fly (*Metagonistylum minense*) for this, the largest cane-growing district in the island. The introduction of this parasite has proven completely successful, and will form the subject of a separate report to be issued shortly.

Dennery.—Recoveries of *Lixophaga* had been made in two fields in the relatively wet sections of Resource and Richefond in January, 1934, but in the summer survey no traces of the parasite could be found, though there was some evidence of a reduced borer infestation in this district. At La Caye, which is comparatively dry, every field was found colonised in August-September, parasitism of *saccharalis* to the extent of 30 per cent. being recorded in some fields. A few examinations made in January, 1935, showed *Lixophaga* to be then present in the Resource area, presumably by natural spread from La Caye.

Vieux-Fort.—*Lixophaga* has not been recovered once from this district, which is curious, as, owing to the general xerophytic nature of the country, it was expected that the parasite would here find conditions most suitable for its establishment and spread. A supplementary campaign with *Lixophaga* was carried out, December 1934-January, 1935, with a view to giving it another chance. The results of this experiment are not yet to hand.

Moth Borer Infestation.

Factory counts were made throughout the 1934 crop, and a pre-harvest field examination was made the following December and January for the 1935 crop, which will of course be supplemented by the regular factory examinations to be reported in due course. The data so far obtained are as follows :—

Joint Infestation (Average ; Plants & Ratoons).

	Cul-de-Sac.	Roseau.	Dennery.	Vieux-Fort.
1934 (factory count)	13.5	17.8	No data available	22.6
1935 (pre-harvest exam. of fields)	5.3	5.7	10.0	18.5

THE LEEWARD ISLANDS.

A tour was made by the author from January to March, 1935, the islands being visited as follows : — Antigua from 22nd January to 12th February ; St. Kitts and Nevis from 13th February to 4th March ; Montserrat on 22nd January and from 5th to 26th March ; a few hours were spent in Dominica on 27th March, and the opportunity taken to inspect an infestation of citrus root borers. The results may conveniently be presented as follows :

The Sugar-cane Moth Borer.

[*Diatraea saccharalis* (Fabr.).]

Antigua.

The situation with regard to this pest and the introduced parasite (*Lixophaga*) has been reported† up to November last. During January-February a pre-harvest survey of 154 canefields (112 plants, 42 ratoons) was made, practically every cane-growing district being covered. While the final figures on crop infestation will be secured from

* Being an up-to-date summary of reports submitted to the Commissioner of Agriculture.

† *Tropical Agriculture*, Vol. XII, No. 4, April, 1935, pp. 89-96.

the regular examinations made at Gunthorpe's factory, the following data indicate a continued satisfactory control of the moth borer in Antigua :

	Joint Infestation. 1935 *Crop.*
Pre-harvest exam. of fields. Plant cane only—	
Uncolonised areas (11 fields)	18.2%
Colonised areas (101 fields)	8.2%
Factory count to date (7 weeks of crop) plant and ratoon canes (95 per cent. located in colonised areas)	6.0%

While the time for the regular surveys to determine the status of *Lixophaga* is not due until the summer, the opportunity was taken to make observations on the incidence of the parasite. Two colonies, at Cassada Garden and Betty's Hope Garden respectively, were discovered additional to those found in the 1934 surveys (in May by Box, in November by Myers), and there has been a tremendous increase in the parasite population in the Gunthorpe's-Donovan's section, Throughout this area, as far west as Paynter's and Tomlinson's, the general borer infestation was relatively high (up to 23 per cent. in plant fields), and it is encouraging to note the presence of *Lixophaga* in adequate numbers to effect future control in this part of the island. In two fields especially were *Lixophaga* noted in large numbers, and in one of them (Donovan's 13, P.O.J. 2878 plants, with 23.3 per cent. joint infestation) the parasite population was comparable with that recorded at North Sound in 1932, when 8,000 were estimated to be present per acre. Acting upon suggestions made by the writer the management arranged for the immediate distribution of parasites from this field (due for early harvest) to improve local colonies at seven other estates.

Borer " dead-hearts " were conspicuously scarce in young plant fields (for 1936 harvest) everywhere.

St. Kitts.

In St. Kitts the harvest had commenced at the time of the writer's visit, but 110 fields (87 plants, 23 ratoons) were examined, these being either in course of being cut or to be harvested within a few weeks. The infestation of the canes is shown by the following data :—

	Joint Infestation. 1935 *Crop.*
Field exam. Plant Cane only (87 fields)	5.5%
Factory count to date (Plant and ratoon cane)	7.4%

To gauge the reduction in infestation in St. Kitts since the establishment of *Lixophaga* it may be mentioned that whereas in 1932 and 1933 the island average exceeded 20 per cent. and in 1934 was 11.1 per cent., in the present survey, of the 87 plant fields examined only two were infested above 15 per cent. (maximum, 18.8 per cent.) and no less than 46 were below 5 per cent. and 13 below 2 per cent. joint infestation.

Evidence of the presence of *Lixophaga* was found at every one of the 32 estates visited and in every field having more than ten per cent. joint infestation, without a single exception. In a few cases the parasite was found in fields with extremely low (0.6 per cent.) infestation. In the few relatively heavily infested fields the emerged puparia of *Lixophaga* were extremely abundant and the living ones to be found with little difficulty.

In young fields (for 1936 harvest) *Diatraea* dead-hearts were occasionally fairly abundant (definitely more so than in Antigua), but *Lixophaga* invariably present in numbers. In one such field, at Molineux, the total parasitism amounted to 66 per cent. of all borers.

Nevis.

In June 1934 liberations of fertile female *Lixophaga* were made in suitable fields at Newcastle and Gingerlands. A careful examination was made of several fields in each of these localities on 21st-22nd February, 1935, but no traces were found of the parasites. It is believed that they failed to become permanently established, probably owing to the fact that the cane areas in Nevis are small, more or less isolated and very scattered, with large intervening areas of wild coarse xerophytic vegetation. The difficulties of establishing the parasite under such conditions are considerable, though not insuperable, and might be overcome by a process of continued colonisation spread over several months. The cost of such might, however, be prohibitive, in view of the status of the sugar industry in Nevis, though for this reason alone it might be justified, as the island loses considerably from the ravages of the moth borer.

Examinations were made of 26 fields (22 plants, 4 ratoons) of standing canes, covering most of the districts. In plant fields the degree of infestation varied from 0.3 per cent. in a district just brought under cane cultivation after a lapse of many years (Cades Bay), to 31 per cent. at Stony Grove. The average plant cane infestation was determined to be 12.8 per cent.

Montserrat.

There are three comparatively large areas under sugar-cane in Montserrat, where the crop is grown under more or less estate conditions, viz.: Farrell's Waterworks, and Parsons-Amersham. Examinations were made at each of these districts, and the average infestation of 13 plant fields found to be 14.25 per cent. (max. 30.6 per cent., at Farrell's) ; eight ratoon fields averaged 8.8 per cent. (max. 18.5 per cent., at Amersham). It is probable that in Montserrat not less than 20 per cent. of the annual value of sugar products is lost as a result of moth borer damage to the canes.

The introduction of *Lixophaga* was made in March, 1935, the original stocks coming from St. Kitts. An almost ideal location for the liberation of fertile females was found at Farrell's, and three separate releases were made. It is

planned to make preliminary examinations in May to determine whether the original flies have multiplied to any extent, and to arrange for further liberations if necessary.

Other Sugar-cane Pests.

In Antigua the author was called into consultation with the Agricultural Superintendent in connection with two cases which had been reported of severe damage to growing canes by "white grubs". These are the larvae of the Brown Hardback Beetle (*Lachnosterna antiguae* Arrow). It was found that the grubs were attacking the plants in lands devoid of adequate drainage, their normal habitat in Antiguan cane-fields, and advice was given for the remedying of this state of affairs. These grubs (*Lachnosterna*) chew the roots of the young plants, and occasionally injure the rhizomes but those of another beetle, the Black Hardback (*Ligyrus tumulosus*. Burm.) actually bore their way into planted cuttings, particularly in well manured lands. The grubs of both species but especially *Ligyrus*, are attacked by the parasitic wasp *Campsomeris dorsata* Fabr., which is often seen swarming in the vicinity of infested fields.

In St. Kitts serious damage to a newly-planted field of B.H. 10 (12) by an undetermined Mealybug (*Pseudococcus* or *Ripersia*) was noted; this was in light well-aerated soil on a hill-top at Buckleys. The roots were covered with the insects in various stages of development, and the majority of the plants over at least two acres had succumbed, necessitating the replanting of this area. No practical remedial measures are available in such cases, but the sugar-cane mealybugs constitute a problem requiring detailed study and research, as these pests are of considerable economic importance throughout the cane-growing islands in the West Indies.

Citrus Pests.

MONTSERRAT.

The most important pests of limes are the adults of the Citrus Weevil (locally called "hard-backs") (*Exophthalmus esuriens* Gyl.), and the introduced Green Scale (*Coccus viridis* Green), but considerable damage is also done by the Citrus Mealybug (*Pseudococcus citri* Risso). In July, 1934, possibly owing to the relatively low rainfall of the previous season, very few plantations were free from this pest, and on some of its numerous hosts, *e.g.*, *Acalypha* sp., its numbers were little less than alarming. During March, 1935, the mealybug was less in evidence, but appeared to be increasing, notably on limes and grapefruit; a very heavy infestation on Sea-grape (*Coccoloba uvifera*), however, was noted. As a pest in the Lesser Antilles *Ps. citri* appears to be confined to Montserrat, and while it has been seen in Dominica and St. Lucia, it is so scarce and the colonies so small that the species may safely be relegated to the status of a minor pest in those islands.

INTRODUCTION OF *Cryptolaemus montrouzieri* MULS. INTO MONTSERRAT, 1935.

This ladybird beetle, the original home of which is in Australia, was introduced into Hawaii in 1894 and thence later into California, for the control of citrus mealybugs. It has been distributed from that centre into many parts of the world, and in the West Indies it has been successfully established in Porto Rico for many years.

Through the co-operation of the Imperial Institute of Entomology and the Imperial College of Tropical Agriculture, a consignment of *Cryptolaemus* was despatched by Dr. W. R. Thompson, Superintendent of the Farnham House Laboratory, on 15th February. This was expected to arrive at Montserrat on 5th March, but owing to the transatlantic steamer being delayed through bad weather and failing to connect with the "Nerissa" bound for Montserrat, it did not arrive until 19th March. The insects were thus 32 days in transit, having spent eight days in New York and two in Barbados*. They were shipped in a large Wardian Case which had been stocked with potato-shoots heavily infested with mealybugs, enabling the beetles to feed and breed *en route*. The case was originally stocked with about 500 *Cryptolaemus*, mostly in the pupal stage, and on being opened at Montserrat 150 (120 adults) were recovered in excellent condition. Preparations had been made for their reception, and the ladybirds, except for a few dozen liberated on infested plants at the Botanic Station and nearby, were transferred to five specially constructed breeding cages containing an ample supply of citrus mealybugs feeding on aetiolated potato-sprouts. Two of the breeding units were supplied by, and are being cared for, on behalf of The Montserrat Company, Ltd.

It is planned for the entomologist to make a short visit to Montserrat in early May to inspect the work, which is in the hands of Mr. C. A. Gomez, the Curator, and report on progress.

* We are much indebted to the Barbados Department of Agriculture, and especially to Mr. R. W. E. Tucker, for inspecting the consignment on its arrival at Barbados and arranging for its transhipment to Montserrat. The agents of Messrs. Furness Withy & Co. also took great interest in this shipment and facilitated matters in many ways.

FOR SALE.

FIRST ANNUAL REPORT ON CACAO RESEARCH, 1931, 44 pp. 1 plate. *Price* 1*s*.

SECOND ANNUAL REPORT ON CACAO RESEARCH, 1932, 40 pp. 4 plates. 34 figs. *Price* 5*s*.

THIRD ANNUAL REPORT ON CACAO RESEARCH, 1933, 72 pp. 3 plates, 4 diagrams. *Price* 5*s*.

FOURTH ANNUAL REPORT ON CACAO RESEARCH, 1935. 88 pp., 4 plates, 11 figs. *Price* 5*s*.

To be obtained from the Editor *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

CROP PRODUCTS MANUFACTURE IN 1934.*

Oils, Fats and Soaps, *By Rex Furness.*

Fundamental work by Hilditch and his collaborators has done much to explain the constitution of fats, and industrial methods will soon be based on accurate knowledge of the chemistry of the raw material. The hydrogenation processes have benefited considerably by long-range research, and the hardening of oils by the addition of hydrogen to the unsaturated fatty acids is not so simple as was at first believed. It is now known that solid unsaturated glycerides may be produced, and by varying the conditions of hydrogenation it is possible to obtain a product of definite iodine value, and to produce fats showing widely varying properties.

The invention of "Foraminate" catalysts has been of the greatest importance, and has opened up new possibilities on the technical side. Taking nickel as an example, the new catalyst is prepared by removing the alumina of finely powdered nickel aluminate with caustic soda or other suitable reagent. The nickel oxide remaining has a "foraminate" structure which is not destroyed by reducing the oxide to free catalytic nickel. The nature of the final catalyst varies according to the amount of alumina removed, and widely differing hydrogenation products may be obtained by applying this principle to the technical processes. So far, these new catalysts have not been subjected to extensive trial on a large scale, but experimental results show that they are superior to ordinary catalysts, giving a much reduced fatty acid content and improved colour in the final product.

Preservation of the Manufactured Product.

Much research work of a fundamental nature has been carried out on the oxidative changes which take place in fats and oils, and which cause rancidity, with rapid deterioration of the market value. "Anti-oxygens" have been searched for and found, and it is now possible to preserve fatty products by the addition of extremely small quantities of such substances as maleic acid or cottonseed oil.

The effect of light is also being investigated, and it has been found that blue light favours the development of rancidity most, while green light has the least favourable influence. "Cellophane" wrappers of different colours are being tested in order to obtain the greatest protection from deterioration. Investigations along the same lines have proved that British-made hard vegetable parchment paper contains less iron and copper than greaseproof paper or soft vegetable parchment and such amounts as are present are less readily dissolved by the fat. Copper and iron are both powerful catalysts in the oxidation of fats, and it is of interest to manufacturers to know that the amounts dissolved from hard vegetable parchment are not sufficient to catalyse the deterioration of olive oil. Another important point about hard vegetable parchment is that it does not allow "active" rays of light to pass, and thus no photo-chemical oxidation can take place in the wrapped fat. On the whole, therefore, scientific evidence supports the suitability of this type of wrapping material.

Soap Manufacture.

Progress in the soap industry has been considerable, and the influence on soap formation of the chemical constituents of the various animal and vegetable oils and fats is still being investigated. An important modification in the usual method of soap boiling has been discussed fully by Tate (*Soap*, December, 1933), who suggests that it is advantageous to saponify with concentrated caustic soda solutions, and that there should always be an excess of fat over alkali in the pan until saponification is almost complete. It is now known that weak soda solutions are not required in the initial stages of saponification, and therefore the use of strong caustic soda solutions has no effect on the rate of saponification. Another suggestion is that a considerable amount of salt (about 6 per cent. of the fat) should be present throughout the boil. When boiling is completed, it is only necessary to add weak brine to grain out the soap, and the finished product is said to have a finer texture and greater transparency.

* * *

Rubber. *By S. A. Brazier.*

The improvement in general trade conditions has been well maintained throughout the year and on the whole it looks as if the rubber industry has now reached a position of comparative stability. The effect of the restriction scheme which was adopted in May is difficult to estimate, but the fact is that the price of raw rubber was approximately 4½d. per lb. at the beginning of the year, and it steadily rose to something in the neighbourhood of 7½d. The total world consumption has also risen, and should show a record figure of over 900,000 tons for 1934.

The economic difficulties of the past few years have stimulated research into new uses for rubber, and new products are continually appearing. Crude rubber is now being made available in a finely-powdered form, and is thus comparable with resin and other moulding plastics. According to R. J. Noble, a rubber powder can now be obtained which will pass a 50 or 100 mesh sieve, and does not contain more than 2 per cent. of protective agent. It is claimed that this will cause considerable saving to the manufacturer by facilitating dispersion and saving mechanical power, while the price of the crude material will be approximately the same as that of the

* Abstracted from *Industrial Chemist*, Jan., 1935.

usual market grades. Rubber thread, manufactured from a special latex thread, appears to be gaining in popularity and it is now being used for hats and suits, and also as wool-latex upholstery for the motor car industry.

Chlorinated rubber is still receiving attention as a possible ingredient for chemical resistant paints, and is now being marketed by I.C.I. Limited under the trade name of Alloprene. Originally the general method of production was by chlorination in a solvent such as carbon tetrachloride, but Bloomfield and Farmer have now described an alternative method from latex by the addition of hypochlorous acid. The products obtained by this latter method were found to be stable in daylight and at room temperatures, but decomposed on heating. An alternative method of preparation was to pass chlorine into latex containing an excess of sodium bicarbonate. The chief use of this product at present is in the varnish industry, for the manufacture of acid- and alkali-resisting coatings. It is non-inflammable, and therefore may be particularly useful for coating paper and textiles.

The action of aluminium chloride on crude rubber gives "Plioform", a useful substance for pressure mouldings, since it possesses a high tensile strength with low extensibility. Oxidation products have also showed promise, and Bloomfield and Farmer have carried out a comprehensive range of experiments on the oxidation of rubber with aqueous hydrogen peroxide-acetic acid mixtures. Full details of the properties and applications of the olefine polysulphide type of rubber-like materials, such as "Thiokol", have been published during the year. They have been found to give good ageing, good resistance to oxygen and ozone, and to have remarkable oil-resisting properties.

In spite of the low prices for naturally-produced rubber, a considerable amount of work is still being done on synthetic rubber. This is probably because relative price is no longer regarded as the basis of evaluation, and the main object is the development of the peculiar technical properties of the synthetic product. The chief uses are still those which utilise the superior oil resistance of the material, in products such as washers and valves which are used in handling petroleum, solvents, and vegetable oils. Other advantages now being exploited include greater resistance to the action of heat, flexing, and sunlight, and improved abrasion resistance under certain conditions, together with greater resistance to the permeability of gases. It has also been stated that tyres made partly of synthetic rubber are a commercial possibility, as the material gives greater resistance to abrasion, thread cracking, and oxidation at high working temperatures. It is a noteworthy point that the various forms of natural rubber, such as chicle, balata, and gutta percha, actually differ more widely from the latex of *Hevea brasiliensis* in chemical composition than do the various forms of synthetic rubber.

In U.S.S.R. butadiene is being produced on a large scale, with a yield of 20-34 per cent. of the theoretical, by passing ethyl alcohol over a catalyst consisting of a mixture of alumina and zinc oxide, at slightly reduced pressures. The butadiene is polymerised into rubber by the action of metallic sodium, and the method is therefore similar to that employed by Germany during the war. Russian-grown natural rubber (mainly tau sagyz), and home-produced synthetic rubber, are gradually displacing the imported variety, but at the present time Russia is still largely dependent on supplies of rubber bought in the open market.

D. W. D.

USE OF FULLER'S EARTH GEL ON MOLASSES FERMENTATION LIQUORS.

Bernard Segal (*J.S.C.I.* (1934) 53. 367 T) describes the use of Fuller's Earth gel on Molasses Fermentation liquors to remove their objectionable odour and other properties. He carried out his investigations in South Africa where the disposal of this dunder into rivers is prohibited and the running of the liquor on to the land unsatisfactory. Evaporation in Multiple effect yielded negative results because of the high solids content and the uncontrollable frothing. Examination of both wash liquor and dunder showed them to be acidic in reaction and to contain positively-charged colloidal matter in suspension. It is this nitrogenous colloidal matter which undergoes putrefaction and produces the nuisance. When Fuller's Earth gel is added to the wash liquors, the dispersed proteins are coagulated and the acidity of the liquor reduced by the formation of soluble sodium salts, producing a clear liquor for distillation and the resulting dunder amenable to disposal by any of the methods outlined above. The gel is made by mixing 100 lb. Fuller's Earth with 20 gals. of five per cent. sodium carbonate and diluting with 20 gallons of water. The free acidity of the wash liquor is neutralized with crushed limestone to pH 7.0, the mixture is agitated briskly and the gel added to give a reaction of pH 7.5 to 8.0, and then agitation is stopped and sodium carbonate solution added to increase the alkalinity to about pH 11.0. The coagulated proteins settle rapidly and the supernatant liquor is withdrawn for distillation. The quantities of reagents added produce no appreciable dilution of the wash liquors. The floc, or settlings, obtained is gelatinous, and its compressibility and porosity can be increased by the addition of crushed limestone. It can be dried into an easily friable mass, and contains nitrogenous matter readily assimilated by soil bacteria. In this way, a valuable commercial soil fertilizer or "top-dressing" is obtained.

J. G. D.

REVIEWS.

THE DISEASES AND CURING OF CACAO.

By H. R. Briton-Jones. *Macmillan & Co., Ltd.*, London, 1934 ; 10*s*.

Professor Briton-Jones has very thoroughly digested the information available on the diseases and curing of cacao from all the countries where the crop is grown. He has presented the result, salted by his own experience, in the form most useful to both planters and practising mycologists : the mass of technical mycological description and illustration characteristic of the older type of crop disease handbook has been very properly omitted as being unintelligible to planters and superfluous for the mycologist who has access to relevant specialised literature.

This book would have been welcome even if it could have been dismissed with these comments —but it has a deeper significance : it is a most valuable addition to mycological literature on account of the eminently sound views of the author on questions of control.

In the past, recommendations for the control of disease in the less advanced tropical colonies were largely based on the theory of workers not familiar with tropical crops and local conditions, and on experience in temperate climates. The change that has taken place in comparatively recent years is in this book shown in strong relief by the hard light of economics which illuminates every consideration of control. Notable examples are the demonstrated futility of burying husks and of attempting to dig out and destroy dead trees and roots, when these operations are not only expensive but serve no useful purpose ; and of advising spraying against pod diseases when the cost is much greater than the value of the crop saved. Planters will be readier to accept advice which is so clearly conditioned by common sense.

The author states that one " must be able to read tree language ". The metaphor is a good one, for though one may learn from inanimate books the grammar of this language, fluency can only be acquired by intimate association with the living trees. The laboratory and office are essential parts of our equipment, but a true conception of the tree as a living organism, and of economic conditions, can only be obtained in the farm.

These principles are so excellently illustrated by Professor Briton-Jones that his book is of value to a much wider public than that concerned with cacao alone. Together with Faulkner's and Mackie's " West African Agriculture ", it should be read by all who wish to obtain correct perspective in their ideas of agricultural practice and economics in those tropical countries where the unit of farming is the small holding worked by native labour.

A chapter on the " curing " of cacao, a process in which fungi and bacteria are instrumental, is appropriately included. The fundamentals of the fermentation process have not received adequate attention from those interested in the product, the quality of which is largely dependent on curing, and we hope that research will provide the author with material for the ample revision of this chapter in the next edition.

H. A. DADE.

* * *

DISEASES OF THE BANANA AND OF THE MANILA HEMP PLANT.

By C. W. Wardlaw, Ph.D., D.Sc., F.R.S.E. (*Macmillan & Co.*, 1935.).

A book on the diseases of the banana plant and of the fruit in transport and storage is very welcome. Dr. Wardlaw has written up a full compilation of the data which research has brought to light towards which his own contributions of recent years have been substantial. Panama Disease or Banana Wilt caused by *Fusarium oxysporum* Schl. forms 3 & 4 Wr. (*F. cubense*. E.F.Sm.), the most widely injurious of the diseases receives, as might be expected, most attention. His studies on the phenomena associated with the early stages of infection, an important matter, published already in detail elsewhere, are summarised fully. He has shown that injured root bases are the main courts of entry for the fungus from the soil. The physical barriers produced by the host in part as a general wound response and in part as a response to wound infecting organisms are, as a rule, effective in preventing vascular invasion by the pathogen. The effectiveness of the physical barriers appears to be of about the same order in both susceptible and resistant varieties. The author believes that the difference is shown when the fungus passes the barriers ; in susceptible varieties it is able to grow on freely in the vessels and give rise to systemic infection but is inhibited from further growth in the resistant varieties. This behaviour would seem to point to a biochemical factor—a substance passing from adjacent living host cells into the vessels and either normally present or produced in response to the invading fungus, which is growth inhibiting in resistant varieties but lacks that character in susceptible varieties. It might be feasible by an appropriate inoculation technique on aerial organs of resistant varieties or by other means to obtain direct evidence of such a growth inhibiting substance.

In the Caribbean Region the dwarf Cavendish variety and the other members of its group are very highly resistant to the strains or physiological forms (biotypes) of the fungus present in that area. In the Canary Islands a biotype of the fungus occurs which is able to grow freely in the vessels of the dwarf Cavendish banana and give rise to the disease. Probably there are other biotypes of the fungus. Gros Michel (in the East under other names) is so widely affected that it may be perhaps susceptible to all existing biotypes.

The origin of the disease in the Caribbean area has been a matter for speculation. It was thought at one time that it might have arisen spontaneously under favouring ecological conditions by transformation of closely related saprophytic strains into parasitic strains (presumably physiological mutations) a view to which the reviewer was inclined. The experiences of Hansford in Jamaica and of Reinking in the western and eastern tropics have not supported that view. Reinking has found the disease widely present on many varieties in the Malay Region and it seems probable that it was introduced from the East to the western tropics, and was already endemic in some parts of it (not in all) on one or more susceptible varieties when Gros Michel began to be planted extensively. Drost thought it had passed to Gros Michel from the 'Apple' banana in Surinam, a susceptible variety (Manzana of Cuba, &c.), of wide distribution in the West and East. An outstanding fact is the absence of the disease from the important plantation area near Santa Marta in Columbia. It is a dry area where irrigation is necessary for most of the year and the ecological conditions both climatic and edaphic have been held to be the prime factors in suppressing the disease. There is, however, no Panama Disease history at all in that area and its freedom may be due very well to the circumstance that infection has never been introduced. Planting began in the oldest farm in 1888 some years before active extension of planting in Central America where the disease was subsequently seen for the first time; it is probable that local supplies were sufficient to meet the demands of increased plantings at Santa Marta, so that no introductions have been made from outside sources. The irrigated area in Jamaica with rather similar ecological conditions was for many years free from the disease; it had been carried in the meantime to the banks of the upper reaches of the river and its feeders which supplied water for irrigation. Some ten years ago the disease was introduced into the irrigated plantations by flooding of the river and has spread considerably since.

The author concludes his thorough treatment of Panama Disease with a short account summarising the promising results secured up to date in the attempt to breed for resistance to the disease. It would appear that a more enduring resistance is likely to result by introducing blood of immune seeding species than by crossing varieties liable to infection by one or another biotype of the fungus.*

It seems probable that more will be heard in the near future of the bacterial vascular disease, the so-called 'Moko' Disease due to *Bacterium solanacearum* E. F. Sm. which can be confused rather easily by the uncritical with Panama Disease. Known for many years in Trinidad and later in British Guiana, it was discovered and studied by the author recently on the dwarf Cavendish variety in plantations near Santos in Brazil and has been recorded on the same variety in Italian Somaliland.

Species of *Musa* like so many other crop plants are affected by several virus diseases. The most serious disease of that nature, Australian Bunchy Top, is fortunately not present in the Caribbean area nor in Brazil and the Canary Islands, but is present in Ceylon and Egypt. The Philippine Bunchy Top restricted to varieties of manila hemp (*M. textilis*) is a different virus disease although transmitted by the same aphis (*Pentalonia nigronervosa*). A third disease of the same nature apparently transmitted by the same aphis has been recorded from Australia and perhaps very recently in the Philippines. A mild mosaic occurs in the Caribbean area and apparently a fifth virus disease has been inoculated on to the dwarf Cavendish banana in Florida.

The important investigations carried out by the author in conjunction with the late Dr. L. P. Mc Guire at the Low Temperature Station attached to the College in Trinidad on the fungal and physiological wastage of the fruit in transport and storage is fully summarised in the later portion of the book. There can be little doubt that the organisations concerned with the trans-oceanic transport of the fruit have studied to advantage the carefully recorded data on the bulk storage trials obtained under strictly controlled conditions with commercial and other varieties. Among other points of value it has been shown that rapid cooling to the normal transport temperature does not induce "chill" but is an important factor in the control of fungal wastage. The trials showed also in confirmation of the successful transport of dwarf Cavendish fruit in bulk storage from Brazil that the variety in question can be so carried without undue wastage and that it can withstand a maintained temperature 1 to 2° lower than Gros Michel without risk of chill, lessening fungal wastage appreciably, and ripen thereafter in a normal manner.

The various fungi responsible for wastage in transport are described and the rots induced by them on the fingers and main-stalk at different temperatures illustrated by means of photographs. An unusual but valuable feature of the book is a complete list of all fungi and bacteria recorded hitherto on the banana plant and the harvested fruit with references to the records. Species definitely known to be parasitic are listed in bold type, saprophytes (including potential parasites) in small type and synonyms in italics. The arrangement is alphabetical (with cross references) under the groups and subgroups adopted in Clements and Shear's 'Genera of Fungi'. It may be added that the volume is amply illustrated with 292 figures and that the references to the literature numbering 559 are carried into 1934. Very few typographical errors have been detected. The author must be congratulated upon the achievement of a thorough piece of work.

S. F. A.

* Breeding for resistance in the presence of biotypes of pathogens has been discussed in a recent paper by O. S. Aamodt entitled 'The relation between physiologic forms of phytopathogenic fungi and the problem of breeding for resistance to disease'. (Proc. Fifth Pacific Sc. Congress, 1933, paper Bl. 8.)

THE GENETICS OF GARDEN PLANTS.

By M. B. Crane and W. J. C. Lawrence, *Macmillan & Co., Ltd.*, London. 1934. pp. 236, price 10*s*. 6*d*.

According to the author's preface, "the aim of this book is two-fold: first to give an introduction to the essential principles of genetics and cytology; and secondly, to give an account of recent results in relation to horticulture". It is however, easier to review if regarded as composed of three parts.

In the first three chapters a courageous attempt is made to propound the essential principles of genetics and cytology in 38 pages. It succeeds to a remarkable degree, but it is open to question whether any such effort was worth making. The result is much too concentrated to help the elementary student, and the reader who can appreciate the skill of the compression is likely to find it unnecessary. These pages would have been more usefully employed in easing the pressure in the remaining chapters.

The next three chapters deal with specific examples of Flowering and Ornamental Plants, Vegetable and Salad Plants and Fruits respectively, and will be considered by many to form the most valuable part of the book. The treatment naturally varies with the amount of information available, but as a rule it includes both a catalogue of the genes that have been investigated and a more general account of the constitution of the plant in question. It is at its best where it has been possible to combine with the genetical researches a certain amount of horticultural history. The evolution of the Sweet Pea, the Dahlia and the Strawberry, for examples, as they exist today is outlined with almost pictorial effect. A book written entirely on these lines, if it were possible would be delightful.

The remaining four chapters are concerned primarily with general principles, though illustrated by particular cases. They deal with Bud-sports, Variations and Fluctuations, Incompatibility, Sterility and the Origin of New and Improved Forms. Here, as also in the earlier chapters, not the least valuable feature is the fact that a large part of the text is derived from original investigations of the authors themselves. The phenomena discussed are those which they have played a leading part in discovering and describing, and as a direct result their summary must be of exceptional interest and value to every botanist interested in plant-breeding.

It is only natural that the more advanced principles of modern plant-breeding should have been discovered in more intensively investigated plants of temperate horticulture, but it is already clear that they have many an important bearing on investigations of tropical crops. These principles are still too new to be commonplace and this exposition of them deserves a prominent place on our bookshelves.

E. E. C.

THE COLLEGE SUGAR FACTORY.

Crop 1935.

The College Sugar Factory started grinding operations on Tuesday, March 12th and finished on Saturday, April 6th. The Crop was somewhat shorter than was expected because of the low yields of cane. A total of 556.438 tons of cane were ground, of which the College Farm supplied about 80 per cent. and the Government Stock Farm the other 20 per cent. The College supply consisted chiefly of BH 10/12 and P.O.J. 2878, and it was due to the low yields of the former that the estimate fell short. The juice of the latter variety of cane, even when ground in the proportion of 3 of BH 10/12 to 1 of P.O.J 2878, gave trouble in the clarifiers and never settled as rapidly or as clear as the juice of BH 10/12 by itself. Similar experiences have been recorded throughout the West Indies, and the trouble can be partially alleviated by using an acid clarification. A Thin Cane experiment, involving 8 varieties of thin canes, *e.g.*, Uba, CO 213, &c., was ground plot by plot separately to obtain actual factory figures.

The cane and juice analyses were good, and the following is extracted from the Chemist's Final Report:—

	1935	1934	1933	1931
Pol per cent. Cane	14.06	13.87	12.44	13.77
Fibre per cent. Cane	14.69	14.23	13.63	13.43
Normal Juice—				
Brix	19.96	19.38	17.53	19.12
Purity	82.89	84.42	82.77	82.99
Pol. Extraction	89.23	89.34	89.29	91.52
Boiling House Recovery	85.78	86.23	86.16	82.12
Final Molasses—				
Purity	36.95	37.87	38.35	34.68
Tons Cane ground	556.00	659.00	716.00	857.00
Tons Sugar made	57.339	67.457	65.426	84.186
Tons Cane per ton Sugar	9.70	9.76	10.94	10.18

The Factory grinds during the day only, and the recovery figures are not all that could be desired because of hold-over losses, and losses of sugar due to instruction and research.

Eight Sugar Technology Students worked in the factory, and were in charge of the various analyses, reports and processes. Also nine Third Year Standard Course Students received practical instruction for one week. Research on Clarification processes was carried out, and a "Cuitometer" was installed towards the end of the grinding. Further work will be carried out with this instrument during next crop.

J. G. D.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Phosphatides of the Soy Bean.

The term "lecithin" has been used to describe the phosphatides of the soy bean, but in reality there are two phosphatides present, lecithin and cephalin, the former ranging between 1.65 and 3.08 per cent. of the weight of the seed. The lecithin content of whole hens' eggs is about three per cent., and until recently this was the main source of commercial lecithin. Now the soy bean is used as the raw material, and extraction processes are operating successfully in Germany, Denmark and the United States. Comparatively little research work on this subject has been published, since commercial interests are best served by patents. The method of extraction is simple, but it is based on accurate studies of the physical properties of lecithin, which is believed to be only a part of the original water-soluble phosphatide complex. When soy bean lecithin is extracted, part of the carbohydrate group present in the phosphatide complex is also split off, and cannot be separated by any known solvent. Thus soy bean lecithin has not been prepared with a phosphorus content as high as that of egg lecithin, since as much as 25 per cent. of the extracted product may be carbohydrate in nature. Soy bean phosphatides (commercially called soy lecithin) have a mild, almost neutral taste, readily swell in water, possess great emulsifying power, and are completely saponifiable. It has been found that soy bean lecithin is characterised by a low proportion of fatty acids, absence of unsaturated fatty acids containing a chain of more than 18 carbon atoms, and the presence of linolenic acid.—(*Ind. & Engin. Chem.* News Ed. Vol. XIII, 1935, p. 89.)

* * *

Manganese Salts in Plantation Rubber.

The use of manganese salts in crude rubber manufacture gives a product which, in gum stocks compounded with organic accelerators, has lower tensile strength and modulus, and poorer age resistance, than the control. In rubber-sulphur stocks, it gives poorer tensile strength and modulus, but the age resistance is not seriously affected. The effect of manganese on a tread stock is not as marked as it is in gum stock, but the tensile strength is poorer, and there is definite indication of poorer age resistance. The use of an anti-oxidant improves the age resistance, but has no effect on the original tensile strength. The flex life is not affected, but the abrasion loss of the manganese—contaminated rubber is much greater than that of the control. The use of manganese in any form in the manufacture of crude rubber should therefore be avoided, as this rubber may be innocently used in a compound where its properties would be extremely detrimental to the service performance of the product made from it. (*Ind. & Engin. Chem.* Vol. XXVII, Feb., 1935, p. 172.)

Browning of Orange Juice.

The browning of orange juice involves oxidation as a primary step. The first products of oxidation apparently undergo condensation reactions in which secondary reactions occur, probably amino acid—sugar reactions. Interference with the formation of the primary products of oxidation by removal of oxygen or addition of reducing substances prevents browning. Sulphites and stannous salts are found to be of value in this connection. The addition of small quantities of sulphites or other antioxidants to pasteurized or benzoated orange juices or syrups preserves their colour. The reducing action of stannous salts, as well as the absence of oxygen in the canned orange juice, accounts for the fact that the browning of canned juice does not occur either in plain tinned or citrus enamelled cans, when stored at high or low temperatures.—(*Ind. & Engin. Chem.*, Vol. XXVII, Feb., 1935, p. 186.)

* * *

Cultivation and Manuring of Coconuts.

W. N. C. Belgrave and J. Lambourne recently described in the *Malayan Agricultural Journal* Vol. XXII. pp. 511-17, experiments in progress on seven coconut estates on the cultivation and manuring of coconuts. It is shown that the yields from mature coconuts 10-20 years old on normal soil not overdrained were not increased to an economic degree by manuring, liming or clean weeding. Unmanured plots with the cover controlled were equally productive. On a poor light soil large responses to clean weeding and the application of manures and lime were obtained, but owing to a heavy drop in yield in 1934 definite conclusions are not yet drawn. Where the soil is dry a cover crop may retard both young and older palms. Liming proved of benefit in an acid soil pH 2.0-3.5. The results are tabulated and statistically analysed.

* * *

Impurities in White Sugars.

In the study of possible means of reducing the quantity of the impurities in white sugar, a knowledge of their distribution throughout the crystal mass is obtained by mixing sugar crystals of uniform size with sugar solutions of different densities below saturation, so that proportions varying from 4.3 to 30.0 per cent. of the crystal mass are dissolved. Analyses of the original and resulting sugars show that, in general, over 50 per cent. of the ash, sulphates, chlorides, sodium, potassium, and total nitrogen is located in the outer five per cent of the crystal—*i.e.*, in the surface layer. On the other hand, colour, calcium, and sulphites are more uniformly distributed throughout the whole crystal.—(*Ind. & Engin. Chem.* Vol. XXVII, Jan, 1935, p. 30.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Clarification of Refractory Juices as (P.O.J. 2878). —*By Ward S. Fleshman.*

In Hawaii during the past few years it has become more and more evident that clarification of the juices from certain of the newer varieties of cane (*e.g.*, P.O.J 2878) cannot adequately be effected by ordinary defection with lime. An investigation of the effect of different possible clarifiers was made, a preliminary report upon which has already been published.* Some further details are now given.

Organic Compounds as clarification aids are in general objectionable by reason of their slow rate of reaction. Tannin forms insoluble salts with inorganic substances in the juice, but it carries the wrong electrical charge for the neutralization of most of the impurities in the cane juice. Further it is difficult to remove completely, and imparts colour and odour to the juice. Hydrolytic enzymes as pepsin, it is true, transform complex proteins into simpler ones, but the rate of their reaction is too slow for commercial work.

Inert Materials, such as certain earths and clays, are capable of bleaching the juice and of adsorbing impurities; most of them become intimately mixed with the precipitate resulting from liming, causing the mud to settle very rapidly in a compact form; but against them are the facts, firstly, that too large a quantity is required to produce a useful result, and secondly that they are mostly in such a very fine state of division as to be difficult to settle. Notwithstanding this disadvantage, their further study appears interesting.

Inorganic Compounds of possible use in clarification include sodium aluminate, but the results of a factory trial at Waimanalo were not promising, it being found that nearly all aluminium compounds, though they exert a decided bleaching effect, form a semi-gelatinous precipitate, which is slow to settle and difficult to filter, and is therefore objectionable. Zinc salts are interesting theoretically in that they form a phosphate floc over a wide range of pH values which settles very fast, and removes much of the impurities present. Calcium chloride will certainly clarify refractory juices, but in so doing it lowers the purity, since the chloride ion cannot be removed.

Phosphates provide by far the best and simplest method of aiding the clarification of refractory juices, thus far discovered. They increase the acidity of the juice when added, and their acid radicle can subsequently be removed with lime. In so doing a very beneficial floc is formed, which settles very satisfactorily, occluding and removing impurities with it. Further, the additional phosphate passing into the mud or press-cake gives it some additional value as a fertilizer material.

Sulphitation was found to offer a practical and economical means of dealing with refractory juices, destroying the colloidal nature of certain impurities or acting upon them in some way or other to render them susceptible to easy removal. SO_2 forms a very satisfactory precipitate with lime, the floc of which settles rapidly and occludes and adsorbs suspended matters, while forming a mud which possesses good filtering characteristics. It gives a clarified juice, which was usually very clear, yielding finally a commercial sugar of a lighter colour than with ordinary liming, and low grades which appear to be more easily handled, and finally molasses of a lower purity. While, however, all juices do not respond to sulphitation, those, for example, from drought-stricken cane, it is felt that process is in general the most practical and efficient means of clarifying refractory juices so far investigated.—(*Int. Sugar Jr.*, Vol. XXXVII, No. 436, p. 158, 1935.)

* *I. S. J.*, 1934, pp. 166, 283, 446.

* * *

Alcohol Manufacture in Philippines.—*By J. P. Sto. Domingo.*

Sugar limitation with its inevitable result of excess cane production is a matter of great concern to centrals and cane planters alike. There is a choice of alternatives—either to abandon the excess cane and later on switch to other crops, or to continue production of sugar cane for the manufacture of sugar and alcohol; the latter of these commodities has not yet reached the saturation point in the Philippines. For alcohol production the centrals of these islands have three raw materials: sugar cane, A-molasses and final molasses. On the basis of extensive calculations it is concluded that where the central has a fair-sized sugar quota the best combination is to produce only A-molasses and supplement this with enough cane juice to keep going an alcohol distillery large enough to be economically operated. —(*Int. Sugar Journal*, Vol. XXXVII, No. 436, p. 153, 1935.)

* * *

Wood Sugar.

A good deal has been written, even in the newspaper press, about the possibilities of the sugar which can be made by the hydrolysis of the cellulose of wood; but Dr. H. Claassen, whose opinion on this subject is worth the highest consideration, has reported on the whole against the economy of such processes. He says that as human food the pure glucose made from wood sugar is dearer than the granulated sugar made from the beet, and in any case requirements in glucose are fully met by the factories utilizing starch as their raw material. The cost of alcohol made from wood sugar is only a little lower than that made from potatoes and molasses, and considerably higher than that made from sulphite liquors. Yeast prepared by the fermentation of solutions of wood sugar cannot compete as cattle food with natural fodders rich in albuminoids, oil cake and the like. — (*Int. Sugar Jr.*, Vol. XXXVII, No. 436, p. 157, 1935.)

TREND OF THE MARKETS.

[The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		Preferential.	
	s.	d.	s.	d.
28th March	4	9	8	6¾
4th April	4	11¼	8	8¼
11th April	5	0	8	9
18th April	5	0	8	9
25th April	5	1½	8	10½
2nd May	5	0	8	9¾
9th May	5	0¾	8	9¾
16th May	5	0¾	8	9¾
(*17th May*, 1934)	4	8¼	8	3

Since our last report the market has displayed considerable firmness while holders of raws have continued to offer sparingly. Refiners, on the other hand, have been advancing their prices by 3*d.* per cwt. following a good trade demand and on the firmness of the raw commodity. The outstanding features in April have been (*a*) the publication of the Report of the United Kingdom Sugar Industry Committee under the Chairmanship of Mr. W. Greene, K.C., which contains a Majority Report against continuance of assistance and a Minority Report recommending a further long term period of assistance; (*b*) the Budget Statement which left unchanged the general scales of import and excise duties.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	pence per lb.
27th March	5 7-8
3rd April	5 5-8
10th April	5 1-2
16th April	5 11-16
24th April	5 3-4
1st May	5 5-8
8th May	5 5-8
15th May	5 7-8
(*16th May*, 1934)	6 3-16

After a sharp upward movement in rubber values following the decision of the International Rubber Regulation Committee to alter the exportable percentages for the April/June quarter to 70 per cent. and for the rest of the year to 65 per cent., the market eased up owing to the threatened strike in American tyre factories and uneasiness in regard to the Dutch guilder. With the settlement of the former and more reassuring news regarding the latter a much better tendency was created and prices have become steadier at around 5¾*d.* per lb.

* * *

COPRA.—The market is steady, values being £12 12*s.* 6*d.* for spot West Indian f.m.s. and £12 17*s.* 6*d.* for forward shipment, c.i.f. London.—(*West India Committee Circular*, 25th April, 1935.)

COCOA.—Since our last report the market generally has been very quiet, but New York has moved in a very disappointing way and any improvement will have to come from that direction. The feeling there has been that prices are so low that buying will shortly be stimulated, but so far no encouragement has been forthcoming from that direction. The price of Accra cocoa has been quoted at 22*s.* 3*d.* and locally $5.40 per fanega is paid for plantation cocoa.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

BANANAS.—The demand for bananas is fair, but the Easter trade did not come up to expectation. Prices are unchanged at £18 5*s.* per ton delivered London and £18 nearest station. Brazilians are also in fair demand, the price remaining at £18 nearest station. The imports into the United Kingdom for the fortnight ended April 6th amounted to 601,376 bunches consigned by the following countries: Jamaica, 334,769; Nigeria, 27,951; Gold Coast, 1,109; Canary Islands, 3,730; Honduras Republic, 47,600; and Brazil, 86,217.—(*West India Committee Circular*, 25th April, 1935.)

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed is scarce, and worth 32*s.* 6*d.* to 35*s.* per lb. Distilled is firm at 22*s.* 6*d.* *Lime Juice.*—There are sellers of Concentrated at £4 15*s.*, but no demand is recorded. Raw is steady at 2*s.* to 2*s.* 6*d.* for good to fine Jamaica, lower grades not being wanted.—(*West India Committee Circular*, 25th April, 1935.)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	Egyptian F.G.F. Sakel.
29th March	6.36	8.29
5th April	6.35	8.32
12th April	6.65	8.35
18th April	6.63	8.20
26th April	6.78	8.4[illegible]
3rd May	6.83	—
10th May	6.82	—
17th May	6.89	—
(*18th May*, 1934)	6.23	8.45

Little increase of activity in the American futures market is reported at Liverpool but the tendency of prices to advance indicates a firmer undertone. The provision of a loan for the next American crop would appear to be assured but there is still considerable doubt as to the actual lending figure or as to the whole crop programme.